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THE FIREBALLS OF 1927 AUGUST 10 AND OCTOBER 16.

By WILLARD J. FISHER.

Incited by press reports, the writer has investigated the passage of bright meteors over New England, 1927 August 10 and October 16. Preliminary results have been published in abstract, in *Harvard Bulletin* 851 and 854, and in notes appearing in the daily papers about September 16 and December 2. An editorial writer in a widely read newspaper has commented on these abstracts very favorably, and has drawn from them certain interesting and far-reaching conclusions; and there have been numerous summaries and reviews.

Partly stimulated by this publicity, observers who had not reported in time for the preliminary publications have sent in additional data, the last (and most important) of which arrived January 30, 1928. Professor C. P. Olivier was so good as to give time to a careful review of the original data on the meteors of October 16, and to write a brief note on the conclusions to be drawn; this would be published here, were it not that the additional observations have to a certain extent made obsolete the conclusions of both Professor Olivier and the writer.

In consequence, the writer has made a complete review of all the data and has thoroughly revised computing, plotting and conclusions. It was the intention to reproduce all the reports in the abstracts which were used in the revision, but that would make this paper expensively long. So a compromise is adopted by presenting the conclusions of the revision, with a certain amount of discussion where advisable, and by making a few typed complete copies of the full paper, which may be consulted at Harvard Observatory, or procured on loan, in case anyone desires to make an independent, thorough discussion of data and conclusions.

The revision, with the new data producing certain unexpected connecting links among previous reports, has enabled a reduction in the number of acknowledged meteors from 40 to 28 for August 10, and from 12 to 6 for October 16. With regard to heights, air-paths and numerical results in general the investigation of these two cases has not been very fruitful, and it has not been possible to compute an orbit for any of the meteors. This is, of course, due to the fact that hardly any of the observers noted the watch time of apparition, and no one counted seconds to get the duration of flight. From one point of view the labor and time spent on these meteors must be regarded as valuable mainly for the educational effect. But the fact which has been emphasized by

reviewers of the preliminary publications, that these were cases of the nearly simultaneous fall of several or many fireballs, is not without interest. Many of these came along nearly parallel paths, and hence can reasonably be regarded as members of groups of meteors, though they were so sparsely distributed that a single observer could hardly see more than one of them.

Groups of meteors are, of course, well known. The magnificent showers of Leonids in 1799 and 1833 are famous illustrations on a large scale. The meteoric procession of 1913 February 9 was a very narrow elongated group. The thirteen-minute shower of 1925 November 20, fully observed by but one person,[1] who saw 37 brilliant meteors and then no more, was an intermediate case. The smallest group ever observed as such may have been that of 1863 October 18,[2] which to the naked eye appeared as a single object, but in the field of a comet seeker was found to consist of a swarm of large and small objects, so close together that only 3° behind them their trains coalesced into one. The present instances also illustrate groups of intermediate density, composed of strikingly bright individuals so dispersed that one observer could hardly see more than one meteor.

The editorial mentioned above[3] even classes such groups as "minor comets," belonging between the dense meteoric bunches which form the heads of comets, and the great periodic swarms which trail along the orbits of certain well known comets.

In studying the replies to a broadcast request for information, all degrees of skill and care and capacity are found represented. It becomes a problem of some difficulty to decide which reports and how much of each to use, and what to reject. It is a matter of judgment rather than of systematic procedure, and the computer must take pains to avoid prejudice in the handling of reports.

In particular, the hypothesis of simplicity is a snare. As an example: in the treatment of the meteoric procession[4] of 1913 February 9, able and experienced computers made the assumptions that the meteors observed in Saskatchewan traversed the whole path from Saskatchewan even to beyond the equator and into the South Atlantic, and that the projection of this path on the earth's surface was a great circle. Prejudiced by these hypotheses of simplicity, the computers rejected observations because the stations did not fit a great circle, or because the heights computed from observations were deemed inconsistent with the dynamical necessities of such a long path. Now the great circle hypothesis is certainly and very sensibly wrong, while the hypothesis of identical meteors is not at all necessary. Accepting these alterations in hypothe-

[1] C. P. Olivier, POPULAR ASTRONOMY, **34**, p. 167, 1926.
[2] J. F. J. Schmidt, Stzgb. Ak. d. Wissn. Wien, Math.-Natw. Kl., 48, p. 551-558, 1863.
[3] *New York Herald-Tribune*, 1927 Dec. 3; reprinted in POPULAR ASTRONOMY, **36**, p. 65-66, 1928.
[4] W. J. Fisher, POPULAR ASTRONOMY, **36**, August-September, 1928.

ses, the bona fides, skill and intelligence of the observers become manifest.

Hence, in dealing with the reports of August 10 and October 16, 1927, one must not assume that the phenomena were necessarily due to a single meteor in each case, but evidence of more than one must be looked for. The fact that a meteor was seen by only one observer on August 10 is no more surprising for that date than for any other date. (Thus, in the case of the meteoric procession, the most remarkable meteoric event since the Andromede shower of 1885 played itself out in clear weather and in sight of many millions of potential observers, yet only two reports about it came in from the whole northeastern United States.) The statement that more than one meteor was seen, say in Hartford, within a very short time interval, by observers in different parts of the city, is nothing surprising.

Decision as to the goodness or badness of any report should be based mostly on internal evidence of that report. And, in weighing the internal evidence of that report, it is safe to assume that the observer who goes to the trouble of writing a report is intelligent, if not educated, and is to some degree an idealist.

That numerous bright meteors are to be expected about August 10, in view of the results contained in catalogues, is shown in the following table:

(1) Coulvier-Gravier	total	168 fireballs;	Aug. 9-13	33	20%
(2) Torwald Køhl	"	987 "	"	28	3.5
(3) H. C. O. Index	"	1500± "	"	75	5.0
(4) H. C. O. Meteor photos	"	356 "	"	11	3.0
(5) v. Niessl-Hoffmeister	"	611 "	"	20	3.0

(5/365 = 1.4 percent.)

REFERENCES—

(1) F. A. Coulvier-Gravier, in F. Arago, *Astronomie Populaire*, vol. 4, p. 275-279, Paris, 1857; period covered, 1841-1853; personal observations.

(2) Torwald Køhl, *Nordisk Astronomisk Tidskrift*, **6**, p. 97-99, 1925; period covered, 1875-1924; personal observations.

(3) A card index of fireballs, compiled from literature, but very incomplete. The fireballs of (1) and (2) are not included; the material so far has been taken from Prior's Catalogue of Meteorites (observed falls only), Eastman's Progress of Meteoric Astronomy in America, L'Astronomie and Bulletin de la Société Astronomique de France, Ciel et Terre, and H. C. O. meteor photographs, in the AI series of plates.

(4) Catalogue of H. C. O. meteor photographs, which, of course, includes the AI series.

(5) von Niessl-Hoffmeister, Katalog der Bestimmungsgrössen für 611 Bahnen grosser Meteore.

In all of these the five-day period August 9-13 shows a disproportionately large share of fireballs. The radiants of these are known only for those meteors in v. Niessl-Hoffmeister's catalogue. On plotting these they are found to be widely distributed, mostly over the northern hemisphere, and mostly not near the Perseid radiant.

The large number of fireballs discovered to have appeared on August 10 in 1927, mostly over the relatively small area of New England, is

probably a result rather of the dragnet method of collecting data than of any display unusual for August 10. The coöperation of a nation-wide news organization, the Associated Press, brought the subject to the attention of millions of people and of thousands who had seen fireballs that night. Of these thousands a few sent to Harvard Observatory reports which seemed numerous simply because of the immense number of people reached by the broadcast. This dragnet method, used whenever a great meteor swishes over New England, tends to bring into existence that desideratum desiderandum of meteoric astronomy—a moderately large area with a dense population, all of whose citizens, whenever they see a fireball, count seconds and look at their watches.

The Fireballs of 1927 August 10.

In the Boston morning papers of 1927 August 11 there appeared a brief and vague notice, stating that many residents of Bridgeport, Connecticut, had seen a "meteor, comet or other heavenly object which gave off a bluish light." It was assumed at the Harvard Observatory that the phenomena were worth investigation, and the assistance of the Associated Press was requested and granted, by telephone. By evening on August 16, 189 letters had been received, and before September 8, 249 letters on fireballs (and other topics) and 53 replies to queries had been received. These ranged from Maryland to Nova Scotia and to near Ottawa. That the circulation of the request was efficient is plain without comment. As noted above, reports continued to straggle in until the last (and most important) was received on January 30. The total number of reports on fireballs strictly was 254. Of these, 166 were definite enough to be usable, 24 could not be used because of indefiniteness in the statement of time, and 64 more failed entirely to mention time. Almost all reports were immediately acknowledged by postal card. In 52 cases requests for more information were not answered.

The reduction of the reports was carried on by abstracting on index cards, separation of the abstracts into time groups, plotting the reported azimuths on a large map, scale 25 mi. to 1 in., (in which the use of colors enabled the time groups to be indicated), and careful study of all the data, with the help of the map, to detect concurrent azimuths. It immediately became plain that no one meteor could satisfy all the reports, and the time groups were subdivided so that each final group might reasonably represent a single meteor. Ultimately the number of groups was reduced to 28, beyond which it seemed unreasonable to go. Details of the reduction, computation and of the precise plotting necessary in one case are not here given. The methods used were substantially the same, with some improvements, as were described in Popular Astronomy, vol. 34, 1926, Harvard Separate 31.

A list of the meteors finally acknowledged follows, with discussion reduced to a minimum.

METEORS ABOUT 7:30 E.S.T. = W 75°.

(1) Reports from Bridgeport, Conn., J. Middlemass; North Hero, Vt., Mrs. H. J. Parker; Taunton, Mass., Miss R. E. Waters.

(2) South Dartmouth, Mass., Mrs. Z. D. Kirby; North Eastham, Mass., C. S. Joslyn.

METEORS ABOUT 7:45.

(3) North Head, Grand Manan, Mrs. S. E. M. Smith.

(4) Buzzard's Bay, Mass., F. W. Fabyan and Pres. S. W. Stratton.

METEORS ABOUT 8:05.

(5) Porter Corners, N. Y., H. W. Culp; Beacon Falls, Conn., Miss M. Harkness.

(6) Syracuse, N. Y., Hollis French.

(7) Pawling, N. Y., W. E. Diedericks; Bridgeport, Conn., Mrs. K. Clegg.

METEORS ABOUT 8:15.

(8) Bridgeport, Conn., W. F. Boerum, Mrs. L. W. Shey, G. Szmak; Putnam, Conn., J. S. Shepard; Sandy Hook, Conn., on Lake Zoar, Miss J. E. Fitzroy, E. Wagner.

(9) Prudence Island, R. I., W. C. Appleton, Jr.; Bridgeport, Conn., Mrs. E. C. W. Lockwood.

(10) New Boston, N. H., Miss F. B. Prince; New Harbor, Me., G. C. Gardner.

These fix fairly well two points on the projected path of a meteor about 8:15. Sub-initial point about 4 mi. SW of Naples, Me., height about 60 mi. = 96 km; course towards SWbS; sub-final point perhaps in New Jersey.

(11) Wilton, N. H., G. G. Blanchard.

The following reports, about 8:15, could not be grouped with satisfaction, but were evidently bona fide:

Bridgeport, Conn., Miss M. Golias, Dr. L. Simonson; Denville, N. J., R. P. Winans; Great Kills, Staten Island, W. Doerzbacker (with an excellent report of time); Highland Beach, N. J., Miss L. Biscayart; Long Beach, Long Island, G. G. Rothschild; Ludlow, Mass., A. Whyte; Provincetown, Mass., Mrs. R. Hornblower.

The New Jersey and Great Kills observations could be grouped with either (8) or (9), but it could not be determined which.

METEORS ABOUT 8:30.

(12) Bellmore, N. Y., Miss F. V. Schley; Long Beach, Long Island, M. Alsop; Long Island Sound, night boat eastward, E. D. Thompson; Marydel, Md., Misses A. C. and A. Haeseler.

(13) Huntington, Mass., A. N. McGray.

(14) Chichester, N. Y., B. Gersoni.

METEORS ABOUT 8:45.

(15) Hartford, Conn., C. A. Brodin.

(16) Brooklyn, N. Y., A. Y. Blomley.

METEORS ABOUT 7:55.

This group is large, and its decipherment was difficult. It includes the best determined meteor of August 10, the only one whose path could be traced from beginning to end.

(17) Pompey's Garden, Pride's Crossing, Mass., Q. A. Shaw; Provincetown, Mass., Miss D. G. Mix.

(18) Dorchester, Mass., Miss R. B. Dowd; East Greenwich, R. I., S. Powel; Haverhill, Mass., Miss A. Noyes; Lakewood, R. I., N. L. Toomey; New Bedford, Mass., J. E. Webb; North Dighton, Mass., H. R. Anders; Popham Beach, Me., T. B. Marsh; Worcester, Mass., Mrs. J. S. Lees.

(19) Torrington, Conn., H. G. Ellis.

(20) Albany, N. Y., E. A. Beaupré; Allerton, Mass., C. B. Duncklee; Boston, Mass., H. H. Brigham, Miss E. H. McLauthlin; Catskill, N. Y., L. W. Lampham; Chicopee Falls, Mass., R. E. Gaboury; Fishers Island, N. Y., H. Best; Greenfield, Mass., J. G. Bowker; Groton, Conn., F. W. Gray; Guilford, Conn., Miss E. G. Davis; Whitehall, N. Y., E. W. Peck; Megunticook Lake, Me., R. G. Montgomery; Mystic, Conn., L. E. Vatet; E. 237th St., New York City, Miss M. E. Diggs; Northfield, Mass., G. Paust; Port Chester, N. Y., E. M. Hopkins; Porter Corners, N. Y., H. W. Culp; Ridgefield, Conn., Mrs. W. G. Foster, F. Lincoln; South Dartmouth, Mass., Mrs. E. W. Cole, South Manchester, Conn., E. V. Fish; Sunapee Lake, N. H., H. M. Frauenthal; Uncasville, Conn., S. Schrier; Waterbury, Conn., J. F. Moore; White Plains, N. Y., F. E. Bell; Worchester, Mass., S. F. Green.

The moment of apparition, 7:57.3 W. 75°, is the arithmetic mean of: Albany, just 8:00; Boston (McLauthlin), 7:55; Fishers Island, 8:00, close; Guilford, 7:56±1; Port Chester, 7:50±; Porter Corners, 7:58; Sunapee Lake, 7:55.

The sub-final point was determined by exact computation and large scale plotting, by the intersection of azimuth rays from Albany, Porter Corners, Megunticook Lake, Boston (Brigham), South Dartmouth, Fishers Island, E. 237th St., and Ridgefield, as W 72° 01′ N 41° 58′, weighted mean; spread is E-W 12′, N-S 17′. This point is in Woodstock, Conn.

The sub-initial point was determined as about halfway between Plantagenet and L'Original, Ont., by azimuth rays on the map, from Porter Corners, Ridgefield and Whitehall. The point is about W 74° 50′ N 45° 35′. The projected path on the map passes about 8 mi. = 13 km NE of Whitehall, and between Greenfield and Northfield, satisfying the observations at these three points.

Course, by map, at Woodstock, toward S 27½° E. The result of clearing of perspective the observations at Fishers Island and Boston (Brigham) is a course toward S 39° E, which agrees with the graphical course as well as could be expected. The projected length, on the map, is about 286 mi. = 460 km. The velocity is not to be determined from

the durations noted, which range from 2 sec (motion very slow) to 60 sec, all of these, estimates without counting seconds. The computed height at ending point is uncertain, spreading from 12.8 mi. to 59.4 mi. The weighted mean of all is 30.8 mi. = 49.5 km; the weighted mean from astronomical reference points is 27.4 mi. = 44 km. The initial height is still worse. There are no satisfactory observations of slope of path; the best placed observers, for whom perspective would have the least effect, say that the path was horizontal.

(21) Farmington, Conn., Miss A. Y. Barbour; Beacon Beach, N. J., Miss O. L. Rutherford; New Haven, Conn., H. Whiting; Sakonnet Point, R. I., F. R. Johnston.

These four observations are satisfied by a meteor at 7:57±1, starting nearly over Contacook, N. H., passing over Sakonnet toward S 14° E, and probably ending at sea somewhere SE of Block Island.

(22) Bristol, Conn., E. A. Lavalle; Hartford, Conn., Manuel Segal, G. C. Thompson; Meriden, Conn., W. A. King; automobile on road going (from Mystic) toward Fort Hill, Conn., J. D. Libby.

These are satisfied by a meteor at about 8:00, passing nearly overhead at both Hartford and Bristol, ending not more than 10° from the zenith at Meriden, and appearing as a stationary meteor between Mystic and Fort Hill. Its course was roughly to SE.

(23) South Brooksville, Me., J. F. Cole.

(24) Atlantic Highlands, N. J., Miss A. L. O'Brien; Beacon Beach, N. J., R. J. Hunt; Bronx, New York City, H. S.; Delaware Water Gap, A. de Palmanaer; Hudson River, up night boat below Peekskill, J. L. Haas; W. 185th St. and St. Nicholas Ave., New York City, J. H. Mulvey; Marydell, Nyack, N. Y., Sisters of Christian Doctrine; Paterson, N. J., J. J. Tibbits; Plainville, Conn., Mrs. T. W. Maloney; Portland, Pa., Mrs. L. B. Jones; Ridgewood, N. J., P. E. Vanderbeck, G. F. Millington, G. B. Pope.

The observations at Marydell, at Plainville and on the Hudson River night boat determine the existence of a meteor, and the watch at Linden gives its apparition time as 7:57.

(25) Leonia, N. J., C. L. Lightfoot.

(26) Charlotte, Vt., B. J. Bornemann.

(27) Brittania Bay, P. Q., J. L. O'Connor.

(28) Schenectady, N. Y., S. S. Bourst.

The radiant of (10) was, at New Boston, at 8:15, in azimuth NEbN. The Perseid radiant was about NNE, so that the meteor may perhaps have been a Perseid, if an error of a point may be allowed.

The radiant of (20) was in azimuth N 27½° W. This is impossibly far from the Perseid radiant.

The radiant of (21) was, at Sakonnet, at 7:57, in azimuth N 14° W. The radiant of (22) was, on the Mystic-Fort Hill road, at about 8:00, in azimuth approximately NWbW.

Fireballs (20), (21), and (22) were perhaps members of the same

swarm, not identified in radiant catalogues. No other radiants can be determined from the observations of this evening, even approximately.

A number of observations not used above may indicate other meteors.

Of the 28 admitted fireballs, 15 were directed toward easterly quadrants, mostly toward the SE quadrant; 11 were directed toward westerly quadrants, mostly toward the SW quadrant. The data are in general not precise enough for greater exactness.

The Fireballs of 1927 October 16.

A press dispatch dated Portland, Me., 1927 October 17, described a "swishing meteor" as seen there the evening of October 16. In consequence a request for information was broadcast immediately through the courteous coöperation of the Associated Press. In response there were received 24 reports in all, including two or three received independently of the broadcast. The reports came from a region, not very wide, stretching from near Eastport, Me., to western Long Island.

The discussion of the data was carried out in much the same way as for the meteors of August 10. The following groups were finally admitted, each representing a single meteor.

(1) Dennysville, Me., Mrs. F. L. Gardner; Brownsville Junction, Me., R. Hutchison; Augusta, Me., F. H. Farnum; Cape Elizabeth Light Station, Me., F. A. Sterling; Cambridge, Mass., P. W. Reynolds; Newton, Mass., Mrs. E. A. Plimpton; Thompson, Conn., Mrs. J. R. Gladding; Danielson, Conn., K. A. Darbie; Seaford, Long Island, G. J. Clements.

Six of these stations lie nearly on a great circle, Dennysville to Seaford. The path of the fireball was much longer than the distance from Dennysville to Seaford, which is about 430 mi. = 692 km; course toward SW, quite exactly; height at mid-path, by Augusta observations, 60 mi. = 96 km; appeared at 10:00.

(2) Observatory at Milton Academy, Mass., A. E. Warren; South Middleboro, Mass., V. H. Ickes.

(3) Cambridge, Mass., Miss H. E. Howarth, Miss I. W. Caldwell.

(4) Fall River, Mass., B. K. Hart; Worcester, Mass., H. E. Comtois; Peace Dale, R. I., C. V. Baker.

(5) North Deering, Me., H. L. West.

(6) Long Beach, Long Island, J. J. Farrell.

Of these six fireballs, four had courses roughly parallel, NE to SW, and four came within a few minutes of 10:00. The paths were mostly nearly horizontal, and several of them were very long arcs, even from horizon to horizon.

AMERICAN ASTRONOMICAL SOCIETY.

(Continued from page 605, Volume XXXVI)

THE MASSES AND ABSOLUTE MAGNITUDES OF BINARY STARS.

By John H. Pitman.

The masses and absolute magnitudes of visual, eclipsing, and spectroscopic binaries are compared with Eddington's mass-luminosity curve. There are points of agreement extending over a wide range in mass and magnitude and also points of disagreement. When the difference in magnitude of the components of a visual binary are used to determine the mass ratios, the results are not all in agreement with those determined in other ways. When the mass ratios of spectroscopic binaries are used to determine the difference in magnitude of the components, in thirty percent of the cases unreasonable differences are encountered.

More data are needed, especially parallaxes, before definite conclusions can be drawn.

LINE INTENSITIES IN NEBULAR SPECTRA.

By H. H. Plaskett.

A description was given of a spectrophotometric determination of the total line intensities in the spectra of eight nebulae. From the intensities of the Balmer hydrogen lines thus obtained, and from recent theoretical determinations of the atomic transition coefficients, the relative distribution of the hydrogen atoms among the various stationary states was found.

A comparison of this distribution with that shown by various laboratory sources makes it clear that in the nebulae the Balmer lines are formed by ionization and subsequent recombination. The distribution varies with the velocity of the free electrons prior to recombination, and it is thus possible to compare the intensities of other lines with this free-electron velocity. It is found that the intensity of the O_{III} line N_2 varies uniformly with this distribution of the hydrogen atoms among the stationary states, while on the other hand the line He_{II} $\lambda 4686$, arising from a carrier of the same ionization potential, shows no such relation.

This different behavior throws some doubt on Bowen's identifications of the nebulium lines, and an examination is made of the evidence for and against his hypothesis. No conclusive evidence, one way or the other, is found, and the only conclusion reached is that these identifications must be accepted with a measure of reserve until further evidence of their validity is forthcoming. The paper will appear in detail as a *Harvard Circular* and also in the *Publications* of the Dominion Astrophysical Observatory.

COMBINATION OF ALBANY AND SAN LUIS DECLINATIONS.

By Arthur J. Roy.

The practical completion of the Albany reductions has made possible a refined comparison and combination with the published San Luis results. There have been included in the Albany reductions, $+''.153 \cdot \tan z$ and $-''.003 \cdot \tan^3 z$. The fifth-power term was not considered well enough determined to justify its inclusion. Comparisons were made, Albany *minus* San Luis, for each fundamental star common to the two programs and arranged in order of declination. From 37° north to 27° south, the differences were combined in two-degree groups and the remainder in smaller groups to permit various refinements in the solution. It was assumed that the derivation of corrections to reduce each catalog to a combined system could best be done with equations in the form,

$$\Delta \text{ Albany} = A(\sin z - \cos\phi) + B(\tan z - \cot\phi) + C(\tan^3 z - \cot^3\phi) + D(\tan^5 z - \cot^5\phi).$$

z being the north zenith distance corrected for mean refraction. A solution for eight unknowns was indeterminate, one coefficient being negative. Assuming that the flexure term, A, was common to both catalogs, the following coefficients were derived:

	Albany		San Luis	
A	$+''.328$	$\pm''.037$	$+''.328$	$\pm''.037$
B	$-.497$	$\pm .0272$	$-.1598$	$\pm .0291$
C	$-.00194$	$\pm .00184$	$+.00456$	$\pm .00023$
D	$+.000080$	$\pm .000043$	$-.000031$	$\pm .000028$

The solutions of the normal equations were made by my associate, Mr. Jenkins. The various relationships are shown by including with the tabulation of these corrections, the corrections to PGC, and also the adjusted corrections and the mean correction to PGC.

Decl.	Alb - PGC	ΔAlb	SL - PGC	ΔSL	Alb - PGC (Adjusted)	SL - PGC (Adjusted)	Mean
+87°.5	+″.01	−″.01			″.00		″.00
82.5	+.08	−.02			+.06		+.06
77.5	−.05	−.03			−.08		−.08
72.5	+.04	−.05			−.01		−.01
+67.5	−.03	−.07			−.10		−.10
62.5	−.03	−.09			−.12		−.12
57.5	+.11	−.12			−.01		−.01
52.5	+.21	−.14			+.07		+.07
+47.5	+.35	−.16	+″.07	+″.15	+.19	+″.22	+.19
42.5	+.42	−.19	+.21	−.01	+.23	+.20	+.22
37.5	+.32	−.21	+.07	.00	+.11	+.07	+.10
32.5	+.39	−.24	+.04	+.04	+.15	+.08	+.13
+27.5	+.46	−.26	+.14	+.08	+.20	+.22	+.21
22.5	+.62	−.28	+.27	+.10	+.34	+.37	+.35
17.5	+.57	−.30	+.17	+.11	+.27	+.28	+.27
12.5	+.60	−.32	+.13	+.13	+.28	+.26	+.27
+ 7.5	+.51	−.34	+.08	+.13	+.17	+.21	+.19
2.5	+.51	−.35	+.09	+.13	+.16	+.22	+.19
− 2.5	+.51	−.37	.00	+.13	+.14	+.13	+.14
7.5	+.53	−.38	−.02	+.12	+.15	+.10	+.13
−12.5	+.46	−.38	−.03	+.11	+.08	+.08	+.08
17.5	+.51	−.37	+.04	+.09	+.14	+.13	+.14
22.5	+.56	−.36	+.10	+.08	+.20	+.18	+.19
27.5	+.54	−.33	+.21	+.07	+.21	+.28	+.25
−32.5	+.56	−.27	+.24	+.05	+.29	+.29	+.29
37.5	+.56	−.30	+.19	+.04	+.26	+.23	+.24
42.5			+.24	+.02		+.26	+.26
47.5			+.44	+.01		+.45	+.45
−52.5			+.38	−.00		+.38	+.38
57.5			+.31	−.01		+.30	+.30
62.5			+.02	−.02		.00	.00
67.5			+.09	−.04		+.05	+.05
−72.5			−.04	−.03		−.07	−.07
77.5			−.03	−.03		−.06	−.06
82.5			+.04	−.02		+.02	+.02
87.5			−.05	−.01		−.06	−.06

THE EFFECT OF THE GALACTIC ROTATION IN THE PROPER MOTIONS OF BOSS'S PGC.

By Jan Schilt.

If Oort's interpretation of the systematic run in the observed radial velocities, which follows the sine of twice the galactic longitude, is true, there will be terms in the proper motions, not only depending on $2a$ but also on a. On the other hand, systematic errors in the term of galactic rotation are not necessarily a consequence of systematic errors following $2a$, but may be a consequence of systematic errors depending on a. It is therefore desirable to make a solution from Boss's proper motions, utilizing the components μ_α and μ_δ, as well as from the components

parallel to the galactic plane. In the former solution no systematic errors occur except those which actually depend on $2a$.

The result is $P = 0''.78$ per annum, $l_0 = 349°$, whereas Oort found from the components parallel to the galactic plane $P = 0''.18 \pm ''.010$, $l_0 = 333° \pm 15°$.* The present result represents closely the value expected from radial velocities and distances and is quite comparable with the results obtained by the present author from the proper motions in the two zone catalogues by Gyllenberg ($l_0 = 340°$, $P = 1''.06$), and by Prager ($l_0 = 337°$, $P = 0''.81$). The apparent directions of the center of the stellar system as found from the proper motions is in a greater longitude than found by Oort from the radial velocities. It should be kept in mind, however, that the latter result depends chiefly on the early type B-stars and c-stars, whereas in the proper motions we deal with an average type of stars which is much later. Moreover, there is an appreciable difference between the centers derived from radial velocities for different types of stars; there appears to be a general tendency for the apparent center to move toward a greater longitude for the later types.

THE ACCIDENTAL ERRORS OF FIVE EXTENSIVE SERIES OF PARALLAX DETERMINATIONS.

By Frank Schlesinger.

These series are those in progress at Allegheny, McCormick, Sproul, Mt. Wilson, and the Yerkes Observatories. From a comparison of the determinations for stars that are in common between each pair of these observatories, ten equations of condition were obtained. Their solution yields the five average probable errors. An independent determination of the same quantities was made by a comparison with the Mount Wilson spectroscopic parallaxes; the results of the two tests are accordant, and both indicate that on the average the published probable errors for these five series must be increased by about one-third in order to obtain the true probable errors. Each series shows an increase in the average probable error corresponding to a good plate as the number of plates used in the determination of a parallax increases. This paper is soon to appear in the *Astronomical Journal*.

Bulletin of the Astronomical Institutes of the Netherlands*, **132, 86.

NOTE ON THE PARALLAX OF A STAR IN THE "BLACK HOLE" IN SAGITTARIUS.

By Frederick Slocum.

This "Black Hole" is Barnard No. 92 and lies in right ascension $18^h\ 11^m$, declination —18° 15′. From visual observations with the 36-inch and 40-inch refractors, Barnard came to the conclusion that the black spot is not a hole, but rather some kind of obscuring matter between us and the Milky Way, and that the 12th magnitude star which appears projected on the spot must be nearer than the background of stars in the Milky Way. At his suggestion I tried to see if I could detect any relative parallax of this star. Twenty plates, spread over five epochs, were taken with the 20-inch refractor of the Van Vleck Observatory.

Two solutions were made. In the first, four comparison stars were used, which were in the dense part of the Milky Way very near the edge of the dark spot. The mean distance of these stars from the parallax star is 11′.5 and their dependences, .256, .247, .251, .246. The relative parallax came out —″.0070 ± ″.007 and the proper motion in right ascension, +″.019. The probable error of a single plate is ±″.023. In the second solution, four comparison stars, at a mean distance of 24′.1, were used. Their dependences are .285, .251, .243, .221. The resulting parallax is —″.0097 ± ″.014, and the proper motion in right ascension, +″.016. The probable error of a single plate is ±″.044.

The negative parallaxes, if real, would, of course, mean that the parallax star is more distant than the comparison stars, but, since the values are of the order of their probable errors, they simply indicate that the relative parallax is not large enough to be detected by this method. The large probable error in the second solution is probably due to the fact that the comparison stars are very near the edge of the plate.

AN ASTRONOMICAL PILGRIMAGE.

By Frederick Slocum.

An illustrated talk on a visit to Weil der Stadt, the birthplace of Johann Kepler, made in connection with the meetings of the Astronomische Gesellschaft at Heidelberg in July, 1928.

INTERNATIONAL LONGITUDE RESULTS.

By C. C. Smith.

The longitudes of all the stations for which wireless results have been obtained have been computed at Ottawa. The comparison of these with previously measured longitudes shows a very close agreement with those that have been measured for Ottawa, Vancouver, Washing-

ton, Paris, and Tokio. The Cape of Good Hope, Algiers, Hong Kong, and a few others show fairly large differences. The longitude difference between Ottawa and Vancouver is of particular interest, since there had been a large unexplained discrepancy between the values of this arc as carried through the Canadian and United States nets respectively. The longitude of Seattle was recently confirmed by the U. S. Coast and Geodetic Survey, and the present operation confirms that of Vancouver. The conclusion appears to be that the error lies in the previously determined arc Seattle-Vancouver.

In the longitude operations two field transits were used at Vancouver, and one field transit and the meridian circle at Ottawa; one of the transits used at Vancouver was of the broken-telescope type, the others of the straight type. In the investigation of personal equation it was found that the broken-type telescope gave a constant difference when referred to the meridian circle, while the other two had equations which were composed of two terms, one a constant which was different for the two instruments and the other a term varying with the time and which was the same for these two transits.

Personal equation (instrumental and observational) and the uncertainty of the transmission time (or lag) of signals are the sources of the major part of any systematic errors in these longitude measurements. The accidental errors give an average probable error of $\pm^{s}.002$ for the differences of longitude.

THE PARALLAX AND THE PROPER MOTION OF BARNARD'S STAR.

By Carl L. Stearns.

The parallax of this star was determined from 24 plates taken at the Van Vleck Observatory, using four comparison stars. The least squares solution gave for the parallax $+0''.558 \pm 0''.005$ and for the proper motion in right ascension $-0''.709 \pm 0''.004$.

On account of the rapid motion of the star in declination it was found necessary to apply to each plate solution an additional orientation correction, computed from the measured coördinates of the parallax star and of two comparison stars widely separated in declination.

The star BD $+4°3562$, which is near Barnard's star, and which has been used as a comparison star by at least two observers, is known to have a parallax of $+0''.04$, and its parallax and proper motion were determined from the same plates. The parallax was found to be $+0''.041 \pm 0''.005$ and the proper motion $-0''.073 \pm 0''.004$.

The mean of eight determinations of the parallax of Barnard's star is $+0''.542 \pm 0''.004$. This probable error is computed from the accordance of the eight published values. The probable error computed from the individual probable errors would be $0''.002$.

Three early plates and three late plates were measured in both co-

ordinates to determine the total proper motion. This was found to be 10".261 after corrections for the mean parallactic motion of the comparison stars had been applied.

A NEW INSTRUMENT FOR LAYING DOWN LINES OF POSITION IN NAUTICAL ASTRONOMY.

By H. T. Stetson.

A plotting device has been perfected which makes possible the substitution of a small plotting area for the usual cumbersome charts. It consists of a compact kit twelve by fifteen inches, the surface of which forms a universal chart table to which may be attached the plotting sheets printed with a course protractor, but without scales in either latitude or longitude. The longitude scale is etched on a rule in the form of a T-square, and is graduated both in arc and in time. The various latitude scales needed to make the plotting sheets universal are etched on the surface of a rotating cylinder recessed in a compartment at the left of the board and are brought into view successively by a slight turn of a knurled knob.

For laying out the line of position through any computed point there is provided a line locator which consists of a rectangular sheet of celluloid on which are ruled two sets of parallel lines. It is placed on the plotting sheet so that one of the lines passes through the center of the compass protractor and extends in the direction of the sun's true bearing. The locator may then be moved along this line, and the line of position drawn along the short edge through the point in question.

A compartment within the board provides storage for used and unused plotting sheets, T-square, the line locator, and dividers.

The apparatus has proved itself especially useful in the practical solution of problems in courses in nautical astronomy.

ON THE VARIATION OF LATITUDE WITH THE MOON'S POSITION.

By H. T. Stetson and Margaret Olmstead.

An analysis of the whole series of latitude observations, made by Ross at Gaithersburg from 1911 to 1914, has revealed a striking correlation between the moon's hour angle and the latitude obtained. The data were restricted to results obtained with the photographic zenith telescope and for convenience divided into two periods, 1911 to 1913, and 1913 to 1914. The latter have the smaller probable error.

On the hypothesis that the deflection of the vertical was due in some way to the lunar tidal effects, a study was next made of the correlation of latitude variation with distance and direction from the sub-lunar

point. The resulting graph exhibited a striking rise in the value of the latitude with increasing altitude of the moon up to a maximum at altitude 30°. After this the latitude steadily decreased with further change in altitude. The total range in latitude variation after the seasonal effect had been eliminated was about 0″.08 for the 1913-1914 period, and 0″.09 for the whole series from 1911 to 1914. In the combined curve double weight was given to the 1913-1914 observations, both on account of their greater accuracy and greater number.

Similar curves for azimuth also revealed a striking correlation, maximum values occurring about 30° either side of the meridian.

When the analysis was carried to the hemisphere opposite the moon, the variation was found to be somewhat less and noticeably asymetrical with respect to the observations made when the moon was in the visible part of the sky. Here the value of the latitude remained substantially constant until the moon was 30° above the horizon, after which it fell rapidly with decreasing negative altitude.

The following should be considered as possible sources of plumb-line deviation: 1. Tidal effects in the earth's crust. 2. Differential lunar attraction. 3. Attraction of the oceanic tidal wave. 4. Compression of the earth's crust by excessive weight of passing oceanic tides. 5. Tidal depression of the continental shelf into a more mobile basaltic layer.

The probable order of magnitude of a direct tidal effect in the earth's crust makes such a hypothesis alone hardly tenable as an explanation of the phenomenon.

Meteorological causes, unless a function of the lunar period, should have been practically eliminated in the averaging of between two and three thousand observations. The possibility, however, of the effect of an atmospheric tide may need some consideration. It should be noted that a change in refraction systematically introduced by the passing of an atmospheric tide is of the correct sign for the observed effect.

The importance of the consequences of such an observed effect, however, scarcely needs to be emphasized as it vitally concerns the determination of star positions. It is suggested that a possible partial explanation of the noted discrepancies in star positions from star catalogues of widely distributed observatories may be traceable to this lunar effect.

The investigation is being continued in an analysis of the latitude observations of other stations.

NOTE ON THE MULTIPLE SYSTEM β SERPENTIS.

By P. van de Kamp and A. Vyssotsky.

β Serpentis (R.A. 1900: $15^h\,51^m.6$; decl. 1900: $+15°\,44'$; $3^M.74$, A0) is known as a double star with components of magnitude 3.7 and 9.2 at a distance of 30″.6 and position angle 265°. According to the P.G.C. of Boss, the bright star has an annual proper motion of 0″.094 in posi-

tion angle 127°. As the distance and the position angle of the double have remained unchanged for some forty years (see β G.C.), it is to be concluded that the two stars form a physically connected system.

In the course of the photographic proper motion investigation, the components of the double star BD +15°2906 (R.A. 1900: $15^h\ 39^m.8$; decl. 1900: +15° 37′; magnitudes 8.5 and 10.5; $d = 6''.3$; $p = 322°$) were found to have proper motions practically identical with that of β Serpentis. The proper motions of the three stars as derived from two plates taken nearly thirteen years apart, are given below.

	Relative		Absolute	
	$\mu_\alpha \cos\delta$	$\mu\delta$	$\mu_\alpha \cos\delta$	$\mu\delta$
β Serpentis	+0″.096	—0″.053	+0″.075	—0″.056
BD +15°2906 Bt	+ .089	— .050	+ .068	— .053
BD +15°2906 Ft	+ .099	— .047	+ .078	— .050

The second and third columns give the motions as measured relative to 16 faint stars (about 11th to 12th magnitude) of small proper motion, which were used for computing plate constants. Columns 4 and 5 give the proper motions after applying —″.021 and —″.003 in R.A. and decl. respectively; these amounts being the differences between the Boss absolute motion and the relative motion of β Serpentis. The motion of BD +15°2906 Bt is given in the A.G. Catalogue Berlin A, page 219: $\mu_\alpha \cos\delta = +''.065$, $\mu_\delta = -''.056$.

The probable error of the measured relative motion amounts to about 0″.005, taking into account the effect of uncertainties in the plate constants.

The similarity of the three motions affords considerable evidence for a physical connection between β Serpentis and the double BD +15° 2906. Additional evidence is offered by the fact that the common motion differs 115° in direction from the direction of parallactic motion. Further confirmation lies in the fact that the difference 4.8 in apparent magnitude between β Serpentis and BD +15°2906 Bt. is in agreement with the difference of absolute magnitude belonging to their respective spectra. For β Serpentis has the spectral type A0; while BD +15°2906, according to spectral classification of Vyssotsky on Harvard plates, belongs to the type G5 or, possibly, K. The average difference in absolute magnitude between an A star and a G5 or K dwarf is just about five or six magnitudes.

The mean trigonometric parallax of β Serpentis is $+''.032 \pm ''.007$; and the cluster parallax based on the fact that β Serpentis belongs to the Ursa Major group is $+''.023 \pm ''.002$. Now the angular distance of β Serpentis to BD +15°2906 is 27′.4. Assuming an absolute parallax of 0″.03 for the multiple system, the distance projected on the sky of β Serpentis to BD +15°2906 appears to be about 55000 A.U. or 0.27 parsec.

The same parallax gives $+1^M.1$ for the absolute magnitude of β Serpentis, $+6^M.6$ for that of its nearby companion, and $+5^M.9$ and

$+7^{M}.9$ for the absolute magnitudes of the components of BD $+15°2906$.

β Serpentis is not known to be a spectroscopic binary (Moore's third catalogue, 1924). Thus β Serpentis plus companions form at least a quadruple system.

A NEW SERIES OF SUN-SPOT OBSERVATIONS AND ITS COMPARISON WITH THE ZURICH SERIES.

By Issei Yamamoto.

A new series of daily sun-spot visual observations are being made by Mr. K. Misawa, at Suwa, Japan, and his monthly reports have been regularly published since October, 1921, (*Bulletins of the Society of Astronomical Friends,* and *The Heavens,* Kyoto). The weather has been very favorable; the number of days on which observations were made is, on the average, slightly higher than that at Zürich; and the uniformity in distribution of clear days all through the year is remarkable. The parallelism of the two series, Suwa and Zürich, in terms of "relative numbers of sun-spots," is well shown, and both series indicate that the epoch of maximum activity may be expected in the very near future. Statistically the relation between the Suwa and the Zürich series is not simple before 1926, but after that a newly established relation of a single straight line is apparent.

REPORTS OF OBSERVATORIES
1927-1928

The reports which follow are for twelve months ending June 30, 1928, unless otherwise noted.

ALLEGHENY OBSERVATORY

University of Pittsburgh
Pittsburgh, Pennsylvania

Mrs. Bertha Crissman resigned in February as secretary and computer, after eight years service during which time she had published 160 parallaxes. Miss Esther M. Doody was appointed in her place.

The year was an unfavorable one from the observing standpoint. 1,578 plates were taken with the Thaw Photographic Refractor. About one hundred parallaxes are ready for publication; for three hundred and fifty others all the observing has been completed, and they await measurement and reduction.

A considerable amount of material has been gathered by Dr. Jordan in continuation of his extensive program of extra-focal photometry, and this is nearly ready for publication.

Dr. Burns, in coöperation with the Bureau of Standards and Dr. F. J. Walters of Carnegie Institute of Technology, is continuing the work of pushing our knowledge of precise standards in the iron spectrum down into the Schumann region, with an accuracy of one part in a million. The measures from λ 2800 to λ 8000 are now nearly ready for publication, and standards have been computed as far as λ 2160. In this interval Dr. Burns published the conclusion of the standard solar wave-length program, λ 3592-4107 and λ 4761-5892 as Vol. VI, No. 9, of the Allegheny *Publications.*

A blink microscope and comparator of new design has been nearly completed, with the assistance of a grant of $300 for optical parts from the American Association for the Advancement of Science. In this design the two plates are placed vertically, one above the other, instead of side by side as in most previous instruments.

About five thousand visitors were admitted in the Frick Public Evening Service, in charge of Mr. Ludewig.

HEBER D. CURTIS, *Director.*

BUREAU OF STANDARDS

DEPARTMENT OF COMMERCE

WASHINGTON, D. C.

(For the year 1928)

Results of measurements of standard solar wave-lengths, obtained in coöperation with the Allegheny Observatory by Burns, Meggers and Kiess, were collected and published in the *Bureau of Standards Journal of Research* (*B.S.J.R.*, **1**, 297, 1928). The wave-length values corresponding to 729 lines in the sun's spectrum from 3592.027 A to 7148.159 A were determined relative to standard neon lines. Averaged with others measured at the Mount Wilson Observatory they form a new system of standard wave-lengths adopted by the International Astronomical Union in 1928.

New determinations of wave-lengths were published for the vacuum arc spectrum of titanium (Kiess, *B.S.J.R.*, **1**, 75, 1928) and for the arc and spark spectra of hafnium (Meggers, *B.S.J.R.*, **1**, 151, 1928), and yttrium (Meggers, *B.S.J.R.*, **1**, 319, 1928). The hafnium measurements have positively identified this element in the sun, but since only spark lines are present it is concluded that the hafnium in the reversing layer of the sun is ionized. The first regularities among hafnium lines were announced (Meggers and Scribner, *J.O.S.A. and R.S.I.*, **17**, 83, 1928). Also, the first regulartiies among cobalt spark lines were published, and ionized cobalt was discovered in the sun (Meggers, *Journal Wash. Acad. Sc.*, **18**, 325, 1928). Analyses of other spectra, *e.g.* Yt I, Yt II, Zr I, Zr II, Cr I, Cr II, and V I, have been advanced toward completion, and the results were made available for the revision of Rowland's solar spectrum wave lengths prepared at Mount Wilson.

Kiess has measured the wave lengths of the two yellow lines [D_1] and [D_2] of sodium in absorption, so that the values can be compared with those observed in the sun. The wave lengths of [D_1] and [D_2] are found to be 0.016 A and 0.021 A longer in solar than in terrestrial absorption.

The equipment used for the redetermination of the Newtonian constant of gravitation was somewhat modified, and observations for securing five additional values of this constant were completed last spring. The results should be available before the close of the year.

The modified Hartmann test, developed at the bureau (Gardner and Bennett, *J.O.S.A. and R.S.I.*, **11**, 441, 1925), for measuring the aberrations of axial image points has been extended to permit its application to points off the axis.

The method has been applied to two 6-inch and one 12-inch astronomical objectives, and the results embodied in contours which show the departure of the actual wave front as focussed by the lens from the spherical wave front which would result with an ideal lens. This method of test is particularly important since it yields results similar to those obtained with the lens interferometer, and does not require the use of any optically worked surfaces additional to those of the component under test. A complete test for one image point of an equatorial telescope requires a single exposure with a small screen and plate holder mounted in a draw-tube, instead of the usual large Hartmann diaphragm in the plane of the objective. The results are readily interpreted in terms of the wave theory instead of in terms of geometric optics.

In its investigation of artificial sunlight sources for use in both colorimetry and photography the bureau has constructed a series of filters which can be reproduced from specifications and which give a color and light distribution closely matching that of mean sunlight as determined by Abbot. The filters are made up of a duplex cell consisting of three borosilicate glass plates, separated by two glass frames and containing solutions of pyridine with aqueous copper sulphate and an aqueous mixture of copper sulphate and cobalt ammonium sulphate (Davis and Gibson, *Trans. Soc. Motion Picture Eng.*, **12**, 225, 1928).

The Seventh International Congress of Photography recommended that a certain definite light source (a grey body at a color temperature of 2,360° K) with one of the filters of this series be adopted as the international standard unit of intensity for the sensitometry of photographic materials (*Brit. Journ. Photog.*, July, 1928).

A second group of filters has been constructed which are suitable for high-temperature measurements. It is planned to extend their application to determinations of the color temperature of stars.

Some additional details concerning the molding of the large disk for the mirror of the telescope at the Perkins Observatory may be of interest. The combined mold and annealing furnace consisted of a cast-iron base and lid each 85 inches in diameter and 2 inches thick, separated by

a ring 81 inches in diameter, 2 inches thick, and 19 inches high. The bottom and sides of the mold were lined with a very friable brick. This assembly was placed on a compacted layer of powdered diatomaceous earth which served as a thermal insulator, and finally the entire assembly was covered with the same material 12 inches in thickness. Plates containing high electrical resistance wires were placed between the cast iron and the insulation in such a way that uniform temperature could be obtained and controlled.

The maximum temperature noted in any part of the furnace immediately after casting the glass was 1,000° C, and since there was no danger of the glass cracking at temperatures above 600° C it was allowed to cool as rapidly as it would to this temperature, which was reached in about eight days. Then, by means of the electric heaters, this temperature was maintained for three days in order to obtain as uniform a temperature throughout the furnace as was possible. The glass was cooled slowly during two months from 600° to 460° C, at which temperature the glass was annealed for six weeks. Approximately five months were then required to reduce the temperature to that of the furnace room, and although the initial cooling rate from annealing temperature was approximately 1° per day it finally reached a maximum of 6° C per day.

The furnace was uncovered on January 21, 1928. Before the glass could be examined for strain it was necessary to remove the adhering particles of brick which had fused with the glass on the lower surface. This was done with a flat steel disk using coarse carborundum and water. Although this left the surface "rough ground," it could be made sufficiently transparent for the purpose by coating it with mineral oil. The upper surface was so smooth that it needed no preparation.

The disk was stood on edge and examined for "strain" or quality of annealing by means of plane polarized light. The strain was found to be symmetrical with respect to the shape of the disk, and the maximum strain detected produced a relative retardation equivalent to 6 millimicrons per centimeter thickness. This is well within the maximum strain permissible in optical glass used in high-precision instruments.

A hole was drilled at the optical axis with an 8-inch brass tube attached to a radial drill press, using water and 150-mesh carborundum in the cut. Seventy hours were occupied in cutting this hole. The work could probably have been done in less time, but the possibilities of excessive local heating and breaking the glass would have been greater.

Although the quality of annealing indicated that this hole might be made without danger of breaking the glass, precautions were taken to protect the optician in case the glass did "explode." These consisted of bedding the glass on sand and surrounding it with a cast-iron ring and covering it with planks and sheet steel except for the hole through which the cutter worked.

The difficulties met with in producing a large mirror are so great as

to indicate that progress along the lines of recording more accurately what the telescope sees, is as important as further increase in the size of the object glass or mirror.

For instance, any increase in the sensitivity of photographic materials is equivalent to an increase in size of objective.

The preparation of photographic emulsions is a secret and largely empirical art, of such complexity that it has been neglected as a means of investigation of photographic problems. The Bureau has been engaged for several years in a quantitative study of the process; the second paper on this subject, dealing with the function of sensitivity nuclei, is now in press. Special attention is also being given to problems in color sensitization, which may be of more immediate utility.

G. K. BURGESS, *Director.*

DEARBORN OBSERVATORY

NORTHWESTERN UNIVERSITY

EVANSTON, ILLINOIS

The efforts of the Dearborn Observatory staff, as in past years, have been devoted largely to micrometric observations of double stars; photographic observations for stellar parallax; and stellar spectroscopy.

In the first two fields the observations have been of routine character. In the latter, Mr. Elvey has made studies of the contour of absorption lines, principally in the spectra of stars of early types.

The Director and Miss Bennot have completed the manuscript for the Stellar Parallax volume. It is hoped that this may soon be delivered to the press.

A start has been made on planetary investigation under the Camp Endowment for Planetary Research.

Mr. Urie and Mr. Nydigh of the Elgin Observatory have used the facilities of the Dearborn Observatory for preliminary experiments with the photo-electric cell. These experiments are being continued.

The enrollment of students in Astronomy has been the heaviest this year in the history of the Department.

PHILIP FOX, *Director.*

DOMINION ASTROPHYSICAL OBSERVATORY

VICTORIA, BRITISH COLUMBIA

The permanent staff of the Observatory has been increased by the addition of Dr. C. S. Beals, while Mr. R. M. Petrie and Mr. P. M. Millman were temporarily employed as assistants during the summer months. Dr. H. Zanstra also spent one month measuring spectra of planetary nebulae with the microphotometer.

The weather during the year has been much below the average, there being obtained 1143 spectra on 182 nights with a total of 1034 hours

observing, as against a nine-year average of 1637 plates on 203 nights with 1444 hours observing. Allowance must be made though for the fact that upwards of 50 of these spectra were of planetary nebulae or of faint Wolf-Rayet stars requiring several hours exposure, usually only two being secured on any one night. There were thus 82 nights on which only 184 spectra were secured whilst on 100 other nights a total of 959 were obtained. As in previous years two hours of the time of the telescope were given to visitors every Saturday evening, a privilege taken advantage of especially during the summer tourist season. Approximately 30,000 persons visited the Observatory during the year.

The program of O- and B-type stars, brighter than magnitude 7.5, and north of declination —10°, which has been under way for the past four years is nearing completion. Radial velocities for about 375 stars have been determined and only about 400 additional plates are required. With good observing weather, it is hoped to complete this program within a year. Good progress is being made on the A-type program also, there being available now about 850 A-type spectra of which about 220 are of stars with measured parallax. About 150 additional A-type spectra are required to complete the provisional program. In both cases measurement of the radial velocities has kept pace with observation.

In carrying out these programs a number of spectroscopic binaries have been discovered and on some of these as well as on others previously discovered considerable time has been spent. Orbits of two B-type stars, of three A-type and of one F-type have been completed during the year and a revision of B.D. 56°2617 made. The B-type stars are H.D. 176819 and H.D. 176853, the latter showing both spectra and yielding minimum masses of 7.1 and 4.9 times that of the sun. The intensity of the lines of the secondary are only about one-fifth that of the primary. The A-type stars are H.R. 6611, H.R. 6979, H.R. 8210, and the F-type, A Persei, the latter showing both spectra and found to have highly eccentric orbits. The minimum masses are 1.0 and 0.9 times that of the sun.

A study is being undertaken of the brighter Wolf-Rayet stars, using a new short focus camera whose dispersion at $H\gamma$ is about 90 angstroms per millimetre.

A spectrophotometric determination of the continuous spectrum of υ Sagittarii showed that the metallic and not the helium spectrum was the fundamental one. The wave-lengths of about 300 lines in this spectrum were determined.

A full discussion has been completed of the curious composite spectrum of Z Andromedae. The wave-lengths of the lines and their origin with their differences in velocities were obtained and the physical meaning of the observed facts was discussed.

The radial velocities of all O- and B-type stars determined here were analyzed as a test for the hypothesis of a galactic rotation as advanced by Lindblad and previously tested by Oort. The distribution of the 550

stars so used seems to confirm the existence of a rotation of the sidereal system in the galactic plane around a distant centre in longitude 325°.

The wave-lengths of oxygen and nitrogen lines between λ 3800 and λ 4700 have been measured from third order grating plates taken at South Kensington and are to be used in radial velocity work. Some work has been done also on molecular spectra, principally that of silver.

Graphs for facilitating the conversion of equatorial into galactic coordinates and for obtaining the position angle and apical distance of any star were constructed and issued as one of the *Publications*.

There were issued during the year numbers 1, 2 and 3 of Volume IV of our *Publications*, whilst numbers 4 to 9 are nearly through the press.

J. S. PLASKETT, *Director*.

DUDLEY OBSERVATORY

ALBANY, NEW YORK

Reductions of Observations. The San Luis Catalog of positions of 15,333 stars has been published. The reductions of the Albany right ascensions have been completed and but little work remains to be done on the declinations. The Albany Catalog of positions of 20,775 stars should be ready for the printer early in 1929. The greater part of the staff is now being employed on the General Catalog to contain the positions and proper motions of over 30,000 stars and this work is progressing rapidly.

Mr. Varnum has completed a revision of the magnitudes used in the Albany work, so that the reductions and published magnitudes will all be based upon the Harvard system of magnitudes.

Mr. Roy has made a revision of the refractions used in reducing the Albany declinations, introducing the cube of the tangent of the zenith distance and, thereby, appreciably improving the system of declinations.

Variation in the Rotation of the Earth. Mr. Boss has continued his studies of anomalies in the clock corrections and other phenomena giving possible evidence upon the question of variation in the rate of rotation of the earth.

Space Motions. Messrs. Raymond and Wilson have completed the computations of the coördinates of space motions of about 4200 stars for which proper motions, radial velocities, and parallaxes are available. These data are being analyzed for the determination of solar motion, preferential stellar motion, group motions and related problems. Several interesting results have come out of this analysis, which is as yet far from complete.

If the stars are grouped according to their space velocities, both the direction and amount of the solar motion appear to be simple functions of the speeds of the stars used in the determinations, all coördinates increasing numerically with increase in the stellar speeds. With increase of stellar speed, likewise the apex of preferential motion rotates around

the Galaxy in the direction of decreasing longitudes. In other words, the contention of Stromberg that the so-called skew-motion is not confined to the high-velocity stars but continues into the velocity distribution of stars of more moderate speeds is upheld. The coördinates of solar motion derived from stars of different spectral types seem, also, to be directly related to the median speeds of the stars in those classes. The maximum skewness of the velocity distribution of the stars as a whole is directed toward the point ($A = 334°$; $D = +66°$), which is near the Galaxy and nearly 90° from the supposed center of the Galaxy in Sagittarius. Several considerations suggest that the skewness may be the result of rotation in the Galactic plane unequally distributed between the two directions.

Stellar Wave-Lengths. Mr. Albrecht has tested a new Gaertner spectrocomparator, purchased with funds obtained from the Rumford Committee of the American Academy of Arts and Sciences, and found it to be of very high quality. He has determined, also, the wave-lengths of 233 lines in the spectrum of γ Geminorum.

BENJAMIN BOSS, *Director.*

GEORGETOWN COLLEGE OBSERVATORY

WASHINGTON, D. C.

Visual observations of long period variables, chiefly those having faint minima within reach of the 12-inch refractor but not observable with much smaller instruments, together with those made by Mr. Barry with the 5-inch were published regularly in reports of the A.A.V.S.O.

Occultations of stars, including as far as possible the disappearance of all stars down to about the ninth magnitude occulted at the dark limb of the moon were regularly observed and the results for the calendar year 1927 were published in the *Astronomical Journal.*

Personal equation in the observation of occultations has been investigated and two reports presented to the American Astronomical Society. A more detailed account will shortly appear in POPULAR ASTRONOMY.

Work on the reduction and discussion of the longitude observations made during October and November, 1926, is almost complete. The preliminary value is $5^h\ 8^m\ 18^s.15$.

The relative lag of radio time signals received daily from Annapolis and Arlington as compared with observations at the Naval Observatory was studied.

The personnel of the Observatory included Rev. Edward C. Phillips, S.J., Director; Mr. Thomas D. Barry, S.J., assisting as computer and observer, and Rev. Paul A. McNally, S.J., astronomer, who joined the staff on January 1 after spending a year and a half at Berkeley. Bro. Charles Ramage, S.J., continued, as in past year, his efficient services as mechanician.

EDWARD C. PHILLIPS, S. J., *Director.*

GOODSELL OBSERVATORY

CARLETON COLLEGE

NORTHFIELD, MINNESOTA

The major part of the time of the staff was given to teaching and to the publication of POPULAR ASTRONOMY.

The additions to the library consisted of 337 bound volumes and a considerable number of pamphlets.

An instrument-maker was added to the staff in April. His time for a year or more will be spent in rebuilding many of the observatory instruments which have become worn or obsolete.

The time-service, public nights, and meteorological observations were carried on as in former years.

The undersigned spent a portion of his time in further tests of the photo-electric photometer and in revising his text-book on astronomy.

E. A. FATH, *Director.*

LEANDER McCORMICK OBSERVATORY

UNIVERSITY OF VIRGINIA

As a by-product of its work on stellar parallaxes this observatory has started on a big program for determining the proper motions of faint stars. Already we have about 350 regions, rather uniformly distributed over the sky north of 25° of south declination, for which the interval from the early plates is twelve years or more. To this number is added each year about 75 other regions. Each plate on the average contains about sixteen stars brighter than the 12th visual magnitude and an equal number of stars fainter than this magnitude. Mr. Vyssotsky has been at Harvard College Observatory on two separate occasions classifying the spectra of the stars found on the McCormick plates. For the fainter stars he secured additional plates with the 2-foot reflector and objective prism.

On the plates now being taken at the McCormick Observatory to match the early regions surrounding Boss stars an exposure is also made on the North Polar sequence for the purpose of deriving magnitudes. At the present time therefore we have the material available for determining the annual proper motions reduced to the Boss system with a probable error of $\pm''.005$ or less, on about 5000 stars of known magnitude and spectral type distributed rather uniformly over the sky. The motions and magnitudes of an additional 5000 stars will also be known but not their spectral types. This material will give valuable information in regard to solar apex, stream motion, etc.

Two photographic plates each with two images have been taken on all of the list of 150 Cepheids for which proper motions and parallaxes are to be derived by Mount Wilson and McCormick Observatories working in coöperation.

Work on visual binaries for proper motions, and in some cases mass-ratios, has also been started. A total of about 400 stars has been put on this program.

Up to date 900 parallaxes have been completed and over 24,000 plates taken.

Messrs. Mitchell, Olivier and Van de Kamp attended the meetings at Leiden and Heidelberg.

After fourteen years of service, Dr. Charles P. Olivier, associate professor of astronomy, resigned on September 15, 1928, to become the director of the Flower Observatory of the University of Pennsylvania.

On October 1, 1927, Mr. Dirk Reuyl of the University of Utrecht became a member of the staff as Vanderbilt fellow.

S. A. MITCHELL, *Director.*

LICK OBSERVATORY

UNIVERSITY OF CALIFORNIA

MOUNT HAMILTON, CALIFORNIA

Volume XVI of the *Lick Observatory Publications,* familiarly known as "The Radial Velocity Volume," was printed during the year and distributed in February. This brings to conclusion a program of work that had absorbed a large percentage of the resources of the observatory for more than thirty years. The volume gives the detailed measures of 2771 stars brighter than magnitude 5.51. The program was initiated by Dr. Campbell as early as 1896 and the station at Santiago, Chile, was established in 1903 to extend it to the southern stars. In the later years, the program at Mount Hamilton was in charge of Dr. J. H. Moore, and a very large part of the actual work of preparing the results for publication was done by him.

Approximately 15,000 spectrograms were secured at Mount Hamilton, prior to January 1, 1927, and about 10,000 at the Chile Station. More than sixty observers participated in this work, and nearly as many people engaged in the measurement and reduction of the spectrograms. To assure homogeneity in the results thus obtained, the most searching tests were made to detect systematic errors, and corrections were applied to remove any errors brought to light. It is believed that the results as published are free from the effects of any serious systematic errors and constitute not only the most extensive but also the most homogeneous set of radial velocity data available.

Since the data are practically complete for stars to 5.51 magnitude for the whole heavens, Campbell and Moore have utilized them to determine anew the motion of our sun through space. Two solutions were made, using different methods of weighting the observational material, and the close agreement of the results, gives fair assurance that the values of the elements derived have not been affected seriously by

assumptions concerning the particular distribution of the stars.

The completion of this program does not end the work of determining stellar radial velocities. During the year Dr. F. J. Neubauer has been observing the B-type stars fainter than 5.50 and brighter than 8.0 magnitude. This program will end in May, 1929, for the Chile Station has been sold to the Catholic University of Chile. Dr. Neubauer is at present training members of the University staff to take over the work.

A number of special spectrographic investigations have been undertaken. With the 36-inch refractor, 512 spectrograms have been secured (a) to determine the orbits of known spectroscopic binary stars, (b) to get additional data for stars which may prove to have variable radial velocities, (c) to measure the rotation times of the planets Uranus and Neptune, and (d) to secure data for a qualitative study of the spectra of certain bright stars, Cepheid variable stars and the planets Jupiter, Saturn and Uranus. These plates were taken by Messrs. Moore, Menzel, Jacobsen, Brigham and Smith.

Two results of these investigations will be noted here. (1) Moore and Menzel, using the two 1-prism spectrographs, found that the 7 spectrograms of Neptune with the slit set in the position for the planet's equator gave a very noticeable inclination of the spectral lines; those taken with the slit set at right angles showed no inclination. Interpreted as a Doppler effect, the inclination shows definitely that the rotation of Neptune is direct.* The investigation of the rotation period of Uranus is not yet complete; additional spectrograms will be taken in the year 1928-1929. (2) Moore secured four spectrograms of the companion to Sirius in February and March, using a 1-prism spectrograph provided with a 16-inch focus camera lens. Measures of the three plates least affected by scattered light from Sirius gave a gravitational displacement of +19 km/sec. While it is estimated that this result may be uncertain by as much as 5 km/sec, it is interesting and significant that it agrees precisely with the result obtained at Mount Wilson by Dr. W. S. Adams, and as closely as could be expected with the theoretical value.

Dr. Trumpler is continuing his investigations of the open star clusters in the Milky Way and during the year secured 190 spectrograms with the 1-prism spectrograph to study the spectral type and radial velocity of the brighter stars in such clusters. Observations are now complete for six clusters. Sixty-two plates have been measured and the velocities computed. Dr. Trumpler's program contemplates also a photographic-photometric Durchmusterung of all the clusters, about 60 in number, which are under observation for spectral type and radial velocity. It is planned to carry the work to stars of from 13.5 to 15.0 magnitude, according to the character of the cluster and to give also the rectangular coördinates for each star measured. The data will then afford the basis

*The amount of the inclination corresponds to a rotation period of 15.8 ± 1.0 hours, but in view of the difficulty of the observations this figure should be regarded simply as giving the probable order of the rotation time.

for a complete qualitative and statistical study to a definite limiting magnitude.

The 4-inch Ross objectives of the 5-foot focal length have been specially mounted for this part of the work and 159 plates, a little more than half the total number required, have been secured with them.

Dr. Trumpler has completed the definite measurement and discussion of the six "Einstein" plates taken in Australia in 1922 (*L.O.B.*, 297). The confirmation of Einstein's predictions is satisfactory in every respect.

Astronomer W. H. Wright continued his photographic study of the planets Mars, Jupiter, Saturn, and Venus in light of different wave lengths. The very striking differences in detail have not yet been fully interpreted, but in the case of Mars they indicate an atmosphere of greater extent than had before been admitted by observers, and of the presence in this atmosphere of temporary obscurations of at least two different kinds. One of these corresponds, apparently, to the aqueous clouds of our own atmosphere, the other is of a very different character. It is also evident that the Martian atmosphere is less transparent than our own to light of all wave lengths.

Mr. Wright was granted leave of absence from April 15, 1928, to enable him to address the National Academy of Sciences and to accept in person the Draper Gold Medal awarded to him for his work in planetary photography, and his studies of the spectra of the novae and his earlier spectrographic work; also to permit him to give the Darwin Lecture before the Royal Astronomical Society of London, and to attend the meeting of the International Astronomical Union.

After a period of instrumental investigaitons and adjustments, Dr. Jeffers began actual observations to determine places with the Repsold Meridian circle of 1174 reference stars for the photographic reobservation of the A.G. Catalogue $+20°$ to $+30°$, undertaken at the Yale Observatory. Observations were made on 70 nights. It is expected that all the required observations will be secured before the close of 1928. Miss Phyllis Hayford made the reductions in right ascension for the time stars in about 40 sets of observations.

Dr. Jeffers also determined positions of 18 stars in the Coma Berenices Cluster for Dr. Trumpler, and, with the 36-inch and Crossley telescopes, secured some observations of Comet *j* 1927, for the Berkeley Astronomical Department.

Dr. Menzel has continued his study of the flash spectrum plates secured at the various Lick expeditions. It will require at least another year to complete the investigation. Progress has been made in grouping the lines into a series of classes that seem to have a definite physical meaning. It is already apparent that this study will result in a better understanding of the structure of the chromosphere and in a modification of existing theories. In particular, it appears that the effect of electrostatic fields in supporting certain atoms in the chromosphere

against the action of gravity is much greater than has been recognized hitherto.

Dr. Menzel also secured a number of spectrograms of Jupiter, Saturn, and Uranus with various spectrographs, and particularly of the spectrum in the visual region, for the study of strong absorption bands at 6200 A and 7200 A.

In the second semester he was in residence in Berkeley as exchange professor, Professor R. T. Crawford coming to Mount Hamilton.

Dr. Crawford's time was given chiefly to the observation of comets and of the satellite of Neptune, and to other micrometric work. He also computed a definitive orbit for the spectroscopic binary star x Draconis and developed an improved method for computing the orbits of visual binary stars when the orbit plane is parallel to the line of sight.

Dr. Aitken's time was necessarily devoted in large part to administrative duties. His main observing program has been the reobservation of the double stars of his own discovery that have given evidence of orbital motion, and of a few binary stars discovered by others that were at critical points in their orbits. About 500 sets of measures were made during the year.

Work on the Extension to Burnham's General Catalogue of Double Stars also made great progress. Mrs. J. H. Moore was Dr. Aitken's chief assistant, but Miss Phyllis Hayford gave great help by computing precessions for the star places. It is now confidently expected that the manuscript can be sent to the printer before the close of 1929.

Dr. Jacobsen devoted special attention to the spectra of Cepheid variable stars. He also collaborated with Prof. Joel Stebbins, in August and September, 1927, in observations of Jupiter's satellites and of Uranus with the photo-electric cell photometer and continued these observations after Dr. Stebbins returned to Washburn Observatory. In all, his photometric work covered about 50 nights. The results of the measures by Stebbins and Jacobsen and an investigation of the radial velocity curve of S Sagittae have been published.

Miss Hayford's work in assisting Dr. Aitken and Dr. Jeffers has already been noted. In addition she assisted Dr. Menzel in his work on the flash spectrum, computed probable errors for the radial velocities summarized in Volume XVI of the *Publications,* and took charge of the routine library work and of the Wood-Anderson Seismometers.

Miss Jones measured 250 spectrograms, made the necessary reductions to derive the radial velocities, and computed the reductions to the sun for all spectrograms secured during the year. She assisted Dr. Moore in investigations on ϵ Librae and Polaris, and in preparing manuscript and reading proof of Volume XVI of the *Publications.*

Dr. N. T. Bobrovnikoff as Martin Kellogg fellow has studied the rich material stored here in photographs and spectrograms of comets. His previous investigations had shown the importance of a comparative study of cometary spectra and direct photographs secured simultane-

ously. Halley's Comet is particularly adapted to such a study since it is possible to find in the material collected here by Dr. H. D. Curtis (largely his own photographs but in part those made elsewhere) a direct photograph for the date of every spectrogram secured here by Mr. Wright, or in Chile by Dr. Moore.

So far, his results do not conform to the accepted Bessel-Bredichin theory of cometary forms. For example, the tail consists exclusively of CO^+ molecules and fine dust, whereas the envelopes give the Swan spectra and the spectrum of C N as Bredichin's theory demands.

Dr. Bobrovnikoff has secured spectrograms of stars of Classes R and N, in continuation of Dr. Shane's work, and spectrograms of minor planets. The latter show a remarkable weakness in the ultra violet part of the spectrum, a fact that seems to connect these bodies physically with the nuclei of comets. This investigation is being extended to include satellites, Saturn's Rings and different portions of the surface of the moon. Several papers bearing on these studies have been published.

Mr. L. A. Brigham, Lick Observatory Fellow, has secured 145 stellar spectrograms, and various test plates and from these 300 microphotograms with the Moll microphotometer. His thesis is a study of the relative intensities of multiplet lines in the spectra of certain stars.

Mr. N. Wyman Storer remained until December to secure additional data for his thesis. In all, 108 spectrograms were secured and 69 of these were studied with the aid of the Moll microphotometer. Mr. Storer left the observatory in December to fill an appointment at Smith College. He returned in the summer of 1928 and completed his thesis, "A Photometric Study of the Continuous Spectra of Giant and Dwarf Stars."

Mr. Louis Berman and Miss Lois Slocum, Lick Observatory Fellows, spent the academic year at Berkeley and the vacation periods at Mount Hamilton.

Publications and Addresses: Volume XVI of the *Publications* and *Bulletins* 390 to 404 were issued, and many shorter papers were contributed to journals. Mr. Wright's addresses have already been noted. Dr. Aitken gave an address at Nashville, before the American Association for the Advancement of Science, and an address on the progress of astronomy at the Pomona Meeting, Pacific Division, A.A.A.S. Messrs Aitken, Moore, Trumpler and Menzel also gave University Extension lectures and other addresses on astronomical subjects, and Dr. Bobrovnikoff gave several lectures on the theory of cometary structure to the department of astronomy at Berkeley.

R. G. AITKEN, *Associate Director.*

SPROUL OBSERVATORY
SWARTHMORE COLLEGE
SWARTHMORE, PENNSYLVANIA

Mr. Dean B. McLaughlin resigned from the Observatory staff in order to accept a position with the Detroit Observatory at Ann Arbor. Mr. Michel S. Kovalenko was appointed as Assistant Professor of Mathematics and Astronomy to fill this vacancy.

The major activity at the Observatory is, as hitherto, the prosecution of the parallax program. Three hundred and sixty-eight plates were taken on one hundred nights last year for this purpose. The fifth list of 50 parallaxes was completed last year, the results of which are now in press. This work is under the direction of Mr. Pitman. Mr. Kovalenko is taking and measuring photographs of fields taken from ten to fifteen years ago for parallax purposes for the purpose of proper motion. Mr. Miller and Mr. Marriott have been engaged in discussing the eclipse plates made in 1926.

JOHN A. MILLER, *Director.*

(To be continued)

PHENOMENA FOR 1929.

By H. C. WILSON.

ECLIPSES.

During the year 1929 there will be only two eclipses, both of them of the sun. The first will be a total eclipse of more than the average duration, and therefore especially interesting because of the relatively long time available for the study of the phenomena which can be studied only in the few minutes when the light of the sun is entirely shut off by the body of the intervening moon. Near the middle of the path of the moon's shadow across the earth totality will last a full five minutes, while the average duration is less than three minutes.

Unfortunately the path of total eclipse lies mostly across water, the only land touched being the northern part of Sumatra, the Malay Peninsula, a bit of Siam, the southernmost tip of Cambodia, and some of the Philippine Islands. Astronomers in America and Europe will have to travel far to make use of this opportunity, and observing conditions are not likely to be very favorable. (For a discussion of the possible observing stations and list of expeditions likely to be located there the reader is referred to an article by F. J. M. Stratton in the December number of POPULAR ASTRONOMY.)

The second eclipse will be an annular one, i. e. the body of the moon will be too far away from the earth to shut off the entire light of the sun at the middle of the eclipse, leaving a ring or annulus of sunlight as seen from points along the center line of the shadow path. This will be of little interest to astronomers, since almost none of the phenomena attending a total eclipse can be studied, because of the glare of sunlight.

The following information concerning the two eclipses, including Figures 1 and 2, is taken from the *American Ephemeris:*

TOTAL ECLIPSE OF MAY 9.1929

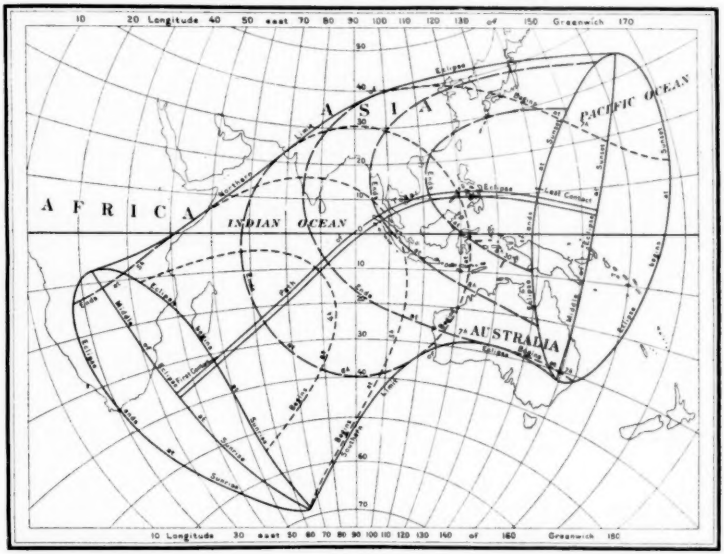

FIGURE 1.

TOTAL ECLIPSE OF MAY 9, 1929.

1. On May 9 there will be a total eclipse of the sun, the path of totality passing from a point south of Africa across the Indian Ocean, the island of Sumatra, the Malay Peninsula and the Philippine Islands, ending in the Pacific Ocean. As a partial eclipse it may be observed in parts of South Africa, Madagascar, India, China, Japan, the northern half of Australia and the islands north of Australia.

The accompanying map, Figure 1, shows where the eclipse will be visible.

The circumstances of the eclipse are as follows:

	Greenwich Civil Time d h m	Longitude from Greenwich ° ′	Latitude ° ′
Eclipse begins	May 9 3 32.5	— 46 47	—31 12
Central eclipse begins	9 4 30.2	— 34 57	—36 46
Central eclipse at local noon	9 5 58.0	— 89 35	— 0 54
Central eclipse ends	9 7 50.1	—153 03	+ 4 48
Eclipse ends	9 8 47.7	—140 28	+10 30

The duration of totality at a few locations along the central line of eclipse is given approximately in the following table:

Location	Longitude ° ′	Latitude ° ′	Duration m s
Indian Ocean off Sumatra	— 94 02	+ 2 32	5 07
Sumatra	— 96 45	+ 4 20	5 06
Malay Peninsula	—101 09	+ 6 43	5 00
Philippine Islands	—119 20	+10 47	3 56
Philippine Islands	—122 35	+10 47	3 44

ANNULAR ECLIPSE OF NOVEMBER 1, 1929.

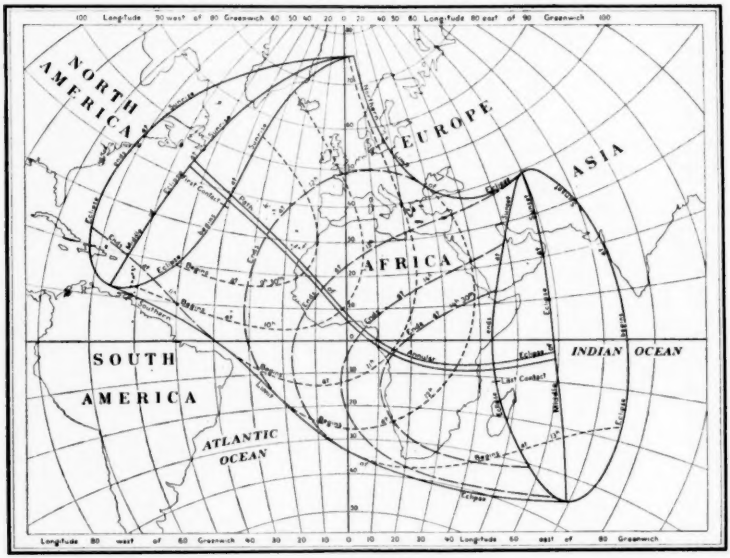

FIGURE 2.

2. On November 1 there will be an annular eclipse, the path of the annular phase passing from a point south of New Foundland southeastward across the Atlantic Ocean, just missing the Canary Islands, across the western part of Africa and the Gulf of Guinea, entering Africa again close to the equator, thence eastward across Africa and ending in the Indian Ocean northeast of Madagascar. As a partial eclipse it will be visible over all of Africa and the southern and western parts of Europe, as well as over the major part of the Atlantic Ocean.

The map, Figure 2, shows the regions where the eclipse may be visible.

The circumstances of this eclipse are as follows:

	Greenwich Civil Time	Longitude from Greenwich	Latitude
	d h m	° ′	° ′
Eclipse begins	Nov. 1 9 12.3	+41 21	+36 17
Central eclipse begins	1 10 18.6	+54 42	+43 27
Central eclipse at local noon	1 11 46.5	+ 0 43	+ 8 23
Central eclipse ends	1 13 50.9	−59 10	− 3 45
Eclipse ends	1 14 57.2	−44 31	−11 06

THE SUN.

On March 21 at $2^h\,35^m$ by Greenwich Civil Time the sun will cross the equator, going north, enter the sign Aries, and spring will technically begin; on June 21 at $22^h\,01^m$ the sun, being farthest north, enters the sign Cancer and summer begins; on September 23 at $12^h\,53^m$ the sun again crosses the equator, going south, enters the sign Libra, and autumn begins; on December 22 at $7^h\,53^m$ the sun is farthest south, enters the sign Capricornus and winter begins.

Sunspots are still numerous so that the study of the changes on the solar surface will be of continued interest during 1929.

The Planets.

As has been our custom for many years, the apparent paths of the planets among the stars during the year have been plotted and these paths are shown on the charts, Figures 3 and 4. (The background of these drawings is copied from Chart SC1, published by the Eastern Science Supply Co.) Figures 5 to 9 inclusive, showing the apparent orbits of the satellites of the planets, are taken from the *American Ephemeris* for 1929.

Mercury is so near the sun that it can be seen only when farthest out, either east from the sun in the evening, or west from the sun in the morning, and even then the background of the stars is hidden in twilight or dawn. Rarely is one of the first magnitude stars near enough to the place of Mercury to be mistaken for the planet. On the evenings of September 9 and 10 the planet Mars will be not far from Mercury but will be much the fainter of the two.

Mercury begins the year near the eastern boundary of the constellation Sagittarius, moves eastward through Capricorn; retrogrades from January 28 to February 19, passing between the earth and the sun on February 7; then moves eastward, roughly along the ecliptic, until May 28; retrogrades in Taurus until June 21, passing between earth and sun on June 9; moves eastward through Taurus, Gemini, Cancer, Leo and Virgo until Sept. 25; retrogrades for a third time, forming a loop in Virgo as it passes between earth and sun on Oct. 8; then from Oct. 16 to the end of the year advances through Virgo, Libra, Scorpio and Sagittarius to a point about ten degrees east of where it began the year.

The times when Mercury can be seen with the naked eye will be within 5 or 6 days on either side of the dates given in the accompanying table, when the planet will be at Greatest Elongation East or West from the sun and thus most free from the solar glare.

Greatest Elongation East. Mercury visible in evening.			Greatest Elongation West. Mercury visible in morning.		
Date		Dist. from Sun	Date		Dist. from Sun
		° ′			° ′
January	22	18 35	March	5	27 14
May	15	21 57	July	3	21 37
Sept.	12	26 48	October	23	18 23

Venus begins its course for the year near the eastern boundary of Capricornus and moves eastward, roughly along the ecliptic except for the one loop which the course makes in Pisces in April and May. The reason for this loop is the retrograde motion due to the passing of the planet between the earth and the sun. The actual passage, or conjunction, will occur on April 20 at about 9:00 o'clock, Greenwich Civil Time. Venus will be at greatest distance east, 46° 48′, from the sun on February 7 and will be at its greatest brilliancy in the evening about March 15. Its stellar magnitude will then be —4.3, i. e. it will be 2.7 magnitudes brighter than the brightest star, Sirius.

Venus will be "evening star" until April 20 and "morning star" for the remainder of the year. Its phase on January 1 is gibbous, a little more than two-thirds of the illuminated half being turned toward us. The phase diminishes gradually, becoming half full on February 10, then crescent, narrowing rapidly until it vanishes on April 20. After that the phase will increase from a thread-

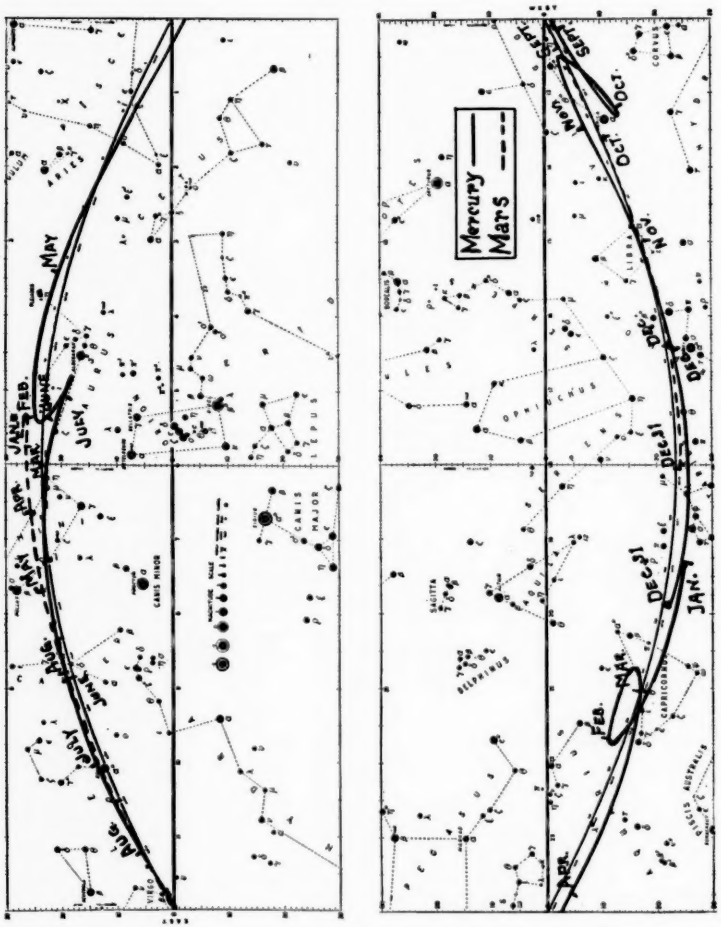

FIGURE 3.
APPARENT PATHS OF THE PLANETS MERCURY AND MARS AMONG THE STARS DURING THE YEAR 1929.

like crescent to half full on June 30 and be gibbous for the remainder of the year. Venus is so bright that it can be seen up to within a very few days of conjunction with the sun and again within a few days after that event. It will attain greatest brilliancy after conjunction on May 26, when its stellar magnitude will be —4.2, almost the same as that at the corresponding position before conjunction.

Mars begins the year in the open space between the three bright constellations, Auriga, Gemini and Taurus, completing the loop which it started in November,

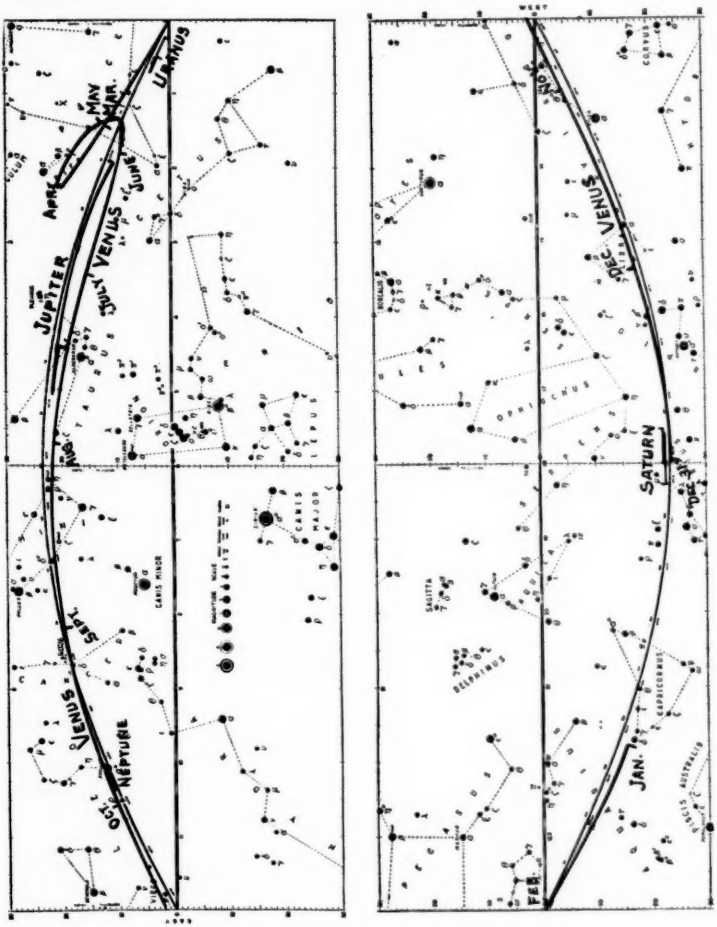

FIGURE 4.

APPARENT PATHS OF THE PLANETS VENUS, JUPITER, SATURN, URANUS, AND NEPTUNE AMONG THE STARS DURING THE YEAR 1929.

1928. After February 1 its course will be eastward, closely following the ecliptic until it ends the year in Sagittarius.

Having just passed opposition to the sun, Mars is now relatively near to the earth (distance 56,000,000 miles January 1) so that it is brighter than any of the stars except Sirius. Its altitude is high in the evening so that, except for the winter temperatures, January will be a favorable time for the study of the surface markings of the planet. Its distance increases rapidly and will be 100,000,000 miles

early in March.

Figure 5 shows the orbits of the satellites of Mars, the apparent widths of the orbits being exaggerated 4 to 1 as compared with their projected lengths, in order to show the relative tilts. The polar diameter of Mars is exaggerated in the same proportion. The orbits are really almost circular and in planes almost edgewise to us. In fact just now the earth is between the two planes.

These two tiny satellites of Mars can be seen only with the aid of large telescopes and excellent atmospheric conditions.

During the next few months it will be interesting to the amateur astronomer to compare the color and brightness of Mars with those of the two red stars, Aldebaran in Taurus and Betelgeuse in Orion. Aldebaran is of magnitude 1.1; Betelgeuse varies from 1.1 to 0.5. The stellar magnitude of Mars is now about —1.2, should be about 0.0 in the middle of February and 1.0 toward the end of March.

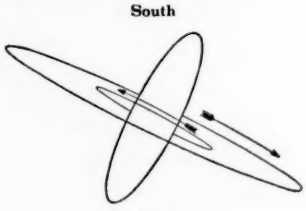

FIGURE 5.

Apparent Orbits of the Satellites of Mars at date of opposition, December 21, 1928, as seen in an inverting telescope.

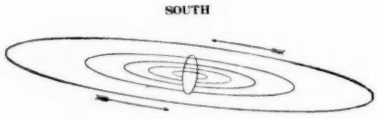

FIGURE 6.

Apparent Orbits of the Satellites of Jupiter at date of opposition, December 3, 1929, as seen in an inverting telescope.

Jupiter will spend the year almost entirely within the constellation Taurus, moving eastward from Pisces to a point nearly south of Capella, October 5, then slowly westward for the rest of the year. Jupiter will be in conjunction with the star Albedaran (α Tauri) on July 28 and again on December 19. In both instances the planet will be about five degrees north of the star. The fall and winter months are the best for the study of Jupiter's surface markings while the planet is in the region of the heavens where it now is. It is approaching the most northern part of its 12-year course around the heavens, so that for observers on our northern hemisphere the planet will be at a high altitude when near the meridian, and thus seen under the most favorable conditions.

The four bright satellites of Jupiter are always interesting objects to observe with small or large telescopes. The times of the phenomena: transits of satellite and shadow across the disk of the planet; occultations behind the planet and eclipse in its shadow, will be given in POPULAR ASTRONOMY for the months when the planet is in favorable position for observation.

Figure 6 shows the apparent orbits of the five inner satellites of Jupiter. The innermost of these (number V) is not visible with small telescopes. The outer satellites, whose orbits are not shown in the diagram, are also invisible except with very large telescopes.

Saturn's course lies wholly in the constellation Sagittarius, advancing until April 9, then retrograding until August 29, then advancing until the end of the

year. This planet will be at opposition to the sun on June 19, so that the best time for observing it will be during the spring and summer months.

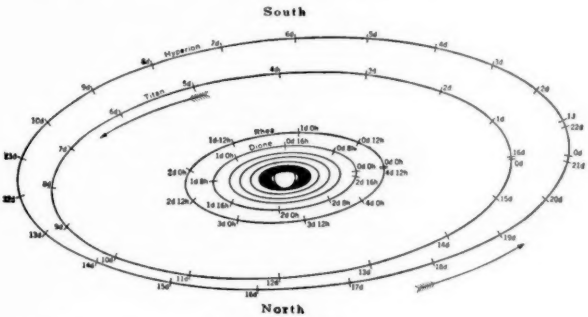

FIGURE 7.

Apparent Orbits of the Seven Inner Satellites of Saturn at date of opposition, June 19, 1929, as seen in an inverting telescope.

As shown in Figure 7, the rings of Saturn and the apparent orbits of the satellites are tipped up at almost their widest angle to the line of sight, so that the rings may be seen at their best. For northern observers the low altitude of the planet will be unfavorable to the best seeing, but in South America, Africa, and Australia, the planet will be high when near the meridian, and the conditions for observing should be fine.

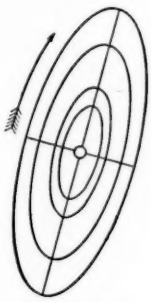

FIGURE 8.

Apparent orbits of the Satellites of Uranus at date of opposition, October 3, 1929, as seen in an inverting telescope.

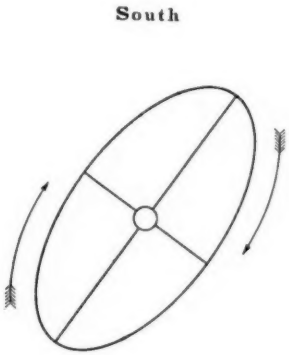

FIGURE 9.

Apparent orbit of the Satellite of Neptune at date of opposition, February 19, 1929, as seen in an inverting telescope.

Uranus will be at opposition on October 3, so that it may be seen best in the autumn months. Its apparent path lies in Pisces, advancing until July 17, retro-

grading until December 17, then advancing to the end of the year. Uranus is visible with a small telescope, but is hard to distinguish from a star. With a large telescope the disc of the planet is noticeable so that it is easily recognized. The satellites may be detected with the aid of a moderately large telescope. The positions of their apparent orbits are shown in Figure 8.

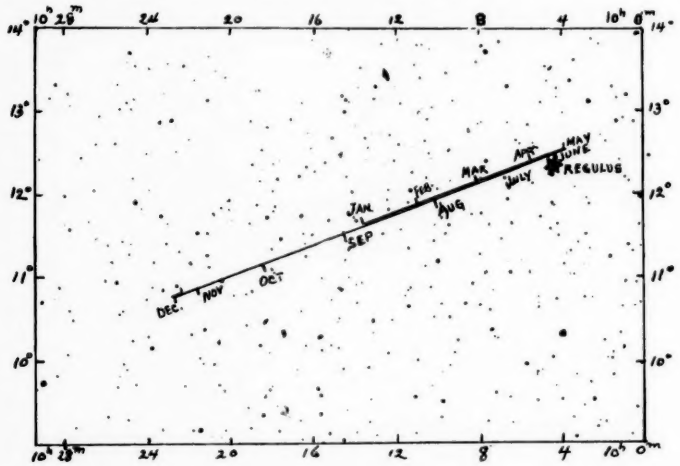

FIGURE 10.

THE APPARENT PATH OF NEPTUNE AMONG THE STARS FOR 1929.
The faintest stars shown are of about the ninth magnitude.

Neptune will be at opposition on February 19, being in good position for observation through the winter. Its course is a short one near the first magnitude star Regulus, so that the planet may be easily found by the amateur with a good telescope of three or four inches aperture. It begins the year about two degrees and a quarter east and 42′ south of Regulus, moves slowly toward the star, passing it 8′ to the north on April 12, and reaching a stationary point 12′ west and 12′ north of the star on May 10. Advancing slowly eastward, the planet will again pass 8′ north of the star on June 7, then continue eastward until December 6 and retrograde during the remaining days of the year.

The apparent orbit of Neptune's one satellite is shown in Figure 9.

COMETS.

Five periodic comets are due to return to perihelion in 1929. The elements of the orbits of some of these are uncertainly determined, so that the comets may be far from the predicted places.

The comets of last year, which are still within range, are exceedingly faint now and can be seen only with the aid of the largest telescopes. New comets, of course, are liable to be discovered at any time.

1. Perrine's periodic comet 1896 VII is due at perihelion about the middle of March. This comet was fairly bright (about 8^M) when discovered on December 8 in 1896. It was then just past perihelion and comparatively near the earth. In 1909, when it did not reach perihelion until late in December, the comet was seen

but was very faint. This year unless the elements of the orbit have changed considerably, the comet will be very unfavorably placed and may escape detection, being on the opposite side of the sun from the earth at perihelion.

2. Daniel's comet 1909 IV should be near perihelion in March, but to be favorably situated for observation its perihelion passage should occur in November, so that if found at all this comet will be only a faint object. It was fairly bright in 1909.

3. Giacobini's comet 1869 V was very faint in 1896. If its orbit has not changed the comet will be near opposition at the time of its perihelion this year, in September, and so may possibly be picked up by a photographic search.

4. Taylor's comet 1916 I, according to the new elements computed by Van Biesbroeck and Chang (See November, 1928, number of POPULAR ASTRONOMY), should be near perihelion early in August. This comet is of especial interest because of its developing a double nucleus in February, 1916. It is important to determine whether one or two comets may be found in its place this year.

5. Metcalf's comet 1906 VI has an uncertainly determined period, but the best elements indicate a return to perihelion in November. It was faint when discovered in October, 1906, and has not been seen since that apparition. At perihelion this comet is outside the orbit of Mars, so that its motion is slow, and it may possibly be picked up months before it comes nearest to the sun.

OCCULTATIONS.

As usual the lists of occultations of the stars by the moon which may be visible in the United States will be published month by month in POPULAR ASTRONOMY. The data for these will be taken from the *American Ephemeris.*

No occultations of planets or of first magnitude stars are predicted as visible in the United States during 1929.

METEORS.

Meteors flash across the sky every night (and in the daytime too, when they are hidden by the brightness of daylight) sometimes in great numbers but generally only a few each hour. Many amateurs are interested in watching the sky for an hour or two continuously on clear nights, and counting the meteors which they see. Some make it a practice to plot the paths of as many meteors as possible on star charts and determine the radiant points of such as appear to have come from the direction of a common point on the celestial vault.

Dr. Charles P. Olivier, director of the Flower Observatory of the University of Pennsylvania, Upper Darby, Pa., is president of the American Meteor Society. He will be glad to hear from any who are interested in observing meteors and to make use of the data which they may contribute.

PLANET NOTES FOR FEBRUARY.

By CLIFFORD E. SMITH.

The *Sun* will be moving northeast from the central part of Capricornus to the central part of Aquarius. Its position on February 1 and February 28 will be respectively, R.A. $20^h\ 56^m$, Decl. $-17°\ 18'$; and R.A. $22^h\ 42^m$, Decl. $-8°\ 14'$.

The phases of the *Moon* will occur as follows:

Last Quarter	Feb.	1 at	8 A.M.	C.S.T.
New Moon		9 "	12 M.	"
First Quarter		16 "	6 P.M.	"
Full Moon		23 "	1 P.M.	"

The moon will be at apogee (farthest from the earth) on February 4, and at perigee (nearest the earth) on February 20.

Mercury will be moving from the eastern to the western part of Capricornus. Its motion will be retrograde until February 19. On February 7 Mercury will be at inferior conjunction, but by the end of the month its elongation will be sufficiently great so that it will rise about and hour and a half before the sun.

Venus will be moving from the western to the eastern part of Pisces, and its apparent motion in the sky will be direct. February 7 Venus will be at greatest elongation east, and at that time it will set about three hours after the sun. On February 8 Venus will be in conjunction with Uranus, and on February 13 it will be in conjunction with the moon.

Mars will be in the eastern part of Taurus. During the middle of the month it will be on the meridian about 8:00 P.M. and its apparent motion during the month will be direct. On February 18 Mars will be in conjunction with the moon and at that time it will be less than the moon's diameter distant from the limb of the moon.

Jupiter will be in the western part of Aries. Its apparent motion will be direct, and during the middle of the month it will set about 10:30 P.M. On February 15 Jupiter will be in conjunction with the moon, and at that time it will be distant from the moon's limb about the distance equal to the moon's diameter.

Saturn will be near the western border of Sagittarius. Its motion will be direct, and, during the middle of the month, it will rise about four hours before the sun. On February 5 it will be in conjunction with the moon.

Uranus will be in the south central part of Pisces, and, during the middle of the month, it will set about two and a half hours after the sun. On February 8 Uranus will be in conjunction with Venus, and on February 13 it will be in conjunction with the moon. Its apparent motion will be direct.

Neptune will be in Leo near the bright star Regulus. On February 19 it will be in opposition to the sun, and, at that time, it will be rising about sunset. On February 23 Neptune will be in conjunction with the moon. Its apparent motion will be retrograde.

Monthly Report of the American Association of Variable Star Observers, for the Month of November, 1928.

The present report is thirty per cent larger than that for the corresponding month of last year. While the number of actual observers is less, the average number of observations, as well as the number of variables observed, is considerably greater.

We regret to have to note the serious illness of our Mr. Rhorer at Atlanta and Miami. We understand that he is slowly recovering and that his Southern Cross Observatory project at Miami for the coming season will function as usual under the guidance of his many enthusiastic colleagues.

VARIABLE STAR OBSERVATIONS RECEIVED DURING NOVEMBER, 1928.

Sept. 0 = J.D. 2425490; Oct. 0 = J.D. 2425520; Nov. 0 = J.D. 2425551.

J.D.	Est.	Obs.
V Scl		
000339		
498	11.3	Bl
508	10.9	Bl
517	10.0	Bl
S Scl		
001032		
495	7.9	Ht
498	7.9	En
498	7.8	Bl
500	7.9	Ht
506	7.8	En
507	7.5	Ht
508	7.7	Bl
515	7.3	Ht
517	7.3	Bl
525	6.9	Dr
527	6.8	Dr
528	6.9	Dw
537	6.0	Dr
X And		
001046		
466	10.4	Bf
521	12.6	Lj
527	12.7	Lj
533	12.8	Lj
535	12.8	Lj
537	12.8	Ch
T Cet		
001620		
527	6.6	L
528	6.5	L
535	6.5	L
540	6.4	L
547	6.4	L
T And		
001726		
522	8.1	Ch
534	8.4	Jo
538	8.6	Ch
541	8.4	Jo
541	8.6	Sc
549	8.7	Sc
551	9.2	Wd
556	9.1	Pt
560	9.1	Wd
564	8.8	Cl
T Cas		
001755		
511	8.4	Ch
519	8.3	Ch
526	8.4	L
534	8.7	Jo
538	9.2	Ch
538	8.6	L
541	8.8	Jo
545	9.2	B
546	9.0	L
554	10.8	Wy
T Cas		
001755		
556	9.0	Pt
557	10.8	Wy
562	9.7	Jo
R And		
001838		
511	6.4	Ch
521	6.5	Ah
523	6.5	Ah
525	6.6	Ah
528	6.7	Sw
532	6.8	Ah
534	6.8	Jo
538	6.6	Ch
540	6.8	Sb
540	6.7	Ah
541	7.0	Jo
541	6.8	Gy
541	7.0	Sc
543	6.8	Ah
544	7.0	Sc
546	6.9	Ah
547	6.9	Ah
549	7.1	Ah
550	7.1	Ah
551	6.8	Wd
551	7.4	Sb
556	7.0	Pt
557	7.4	Sc
558	7.5	Sb
562	7.0	Wd
564	6.9	Wd
566	7.5	Gb
566	7.7	Sb
568	7.4	Wd
569	7.2	Hu
S Tuc		
001862		
498	10.7	En
502	10.2	En
508	10.1	Bl
517	10.0	Bl
S Cet		
001909		
540	14.5	L
540	14.0	Sf
555	13.1	Sf
560	12.9	Sf
T Scl		
002438a		
525	12.8	Dr
528	12.6	Dw
531	12.7	Dr
537	12.2	Dr
RR Scl		
002438b		
525	12.9	Dr
T Phe		
002546		
498	11.8	En
502	11.6	En
508	12.7	Bl
517	12.2	Bl
525	12.1	Dr
528	11.9	Dr
528	11.8	Dw
531	11.7	Dr
537	10.7	Dr
W Scl		
002833		
508	13.0	Bl
525	13.2	Dr
527	13.0	Dr
Y Cep		
003179		
537	10.7	Sf
551	11.2	Sf
560	11.6	Sf
U Cas		
004047		
544	8.5	Sc
545	8.3	B
551	8.6	Sb
556	8.6	Pt
558	8.8	Sb
564	8.6	Cl
567	8.9	Sb
RW And		
004132		
524	11.5	Ch
544	10.5	Sc
V And		
004435		
466	10.1	Bf
557	12.3	B
X Scl		
004435		
508	11.3	Bl
517	10.9	Bl
RR And		
004533		
466	13.2	Bf
RV Cas		
004746a		
545	13.0	B
— Cas		
004746b		
556	10.5	Pt
W Cas		
004958		
534	8.6	Jo
541	8.5	Jo
545	8.3	B
554	8.4	Wy
555	8.2	Hu
556	8.0	Pt
W Cas		
004958		
557	8.4	Wy
562	9.4	Bw
U Tuc		
005475		
498	12.9	En
502	12.9	En
508	14.3	Bl
Z Cet		
010102		
556	9.9	Pt
U Scl		
010630		
508	13.3	Bl
525	13.6	Dr
RU Cep		
010884		
521	8.9	L
522	8.8	L
525	9.0	L
526	8.9	L
527	8.9	L
528	8.9	L
529	8.9	L
531	8.9	L
532	8.9	L
534	8.8	L
538	8.8	L
539	8.8	L
540	8.8	L
542	8.9	L
543	8.8	L
545	8.9	L
551	8.9	L
U And		
010940		
552	13.2	Lg
S Cas		
011272		
512	9.2	Ch
541	10.2	Sc
554	9.8	Wy
556	9.5	Pt
557	10.2	Wy
U Psc		
011712		
537	11.5	Sf
551	11.2	Sf
553	11.5	Lg
556	11.2	Pt
560	11.0	Sf
RZ Per		
012350		
560	10.3	B
564	10.5	Sp
R Psc		
012502		
466	14.0	Bf
R Psc		
012502		
536	11.4	Ch
RU And		
013238		
536	13.1	Ch
552	12.7	Lg
556	13.1	Pt
Y And		
013338		
536	13.0	Ch
545	13.0	B
X Cas		
014958		
524	12.8	Bn
532	12.8	Bn
537	12.6	Bn
545	12.5	B
556	13.2	Pt
U Per		
015254		
545	10.1	B
556	9.5	Pt
562	10.8	Bw
S Ari		
015912		
545	12.5	B
R Ari		
021024		
537	12.7	Ch
545	11.1	B
554	11.0	Wy
556	10.8	Pt
557	10.7	Wy
W And		
021143a		
537	12.9	Ch
556	13.5	Pt
T Per		
021258		
526	8.8	Ch
532	8.9	Ch
555	8.4	Hu
556	8.4	Pt
Z Cep		
021281		
539	13.5	Ch
o Cet		
021403		
497	3.0	En
504	3.2	Br
506	3.4	Br
507	3.4	Br
508	3.5	Br
510	3.5	Br
510	3.2	Ch
511	3.6	Br
512	3.2	Wf
514	3.1	En
o Cet		
021403		
514	3.3	Ch
519	3.7	Ch
523	3.8	Ah
523	3.8	Wf
525	4.0	Ah
527	3.4	L
531	4.2	Wf
532	4.2	Ah
532	4.3	Ch
534	4.1	Sp
534	4.0	Jo
535	3.8	L
538	4.3	Ch
540	4.2	L
540	4.4	Ah
541	4.2	Gy
541	4.5	Sc
541	4.2	Lg
543	4.5	Ah
544	4.7	Sc
546	4.7	Ah
546	4.7	Sc
547	4.8	Ah
547	4.1	L
549	4.8	Ah
550	4.9	Ah
552	5.4	Lg
553	5.4	Lg
554	5.3	Lg
556	5.6	Pt
557	5.6	Hs
557	5.1	Sc
557	5.5	Sp
560	5.6	Wd
560	6.0	Hs
562	5.6	Gy
562	5.7	Wd
564	5.9	Wd
564	5.6	Sp
568	5.6	Wd
569	4.9	Hu
S Per		
021558		
526	9.4	Ch
545	9.2	B
556	8.7	Pt
557	9.3	Wy
558	9.3	Wy
R Cet		
022000		
526	8.3	Ch
532	8.0	Ch
557	9.6	Sc
562	9.7	Sp

VARIABLE STAR OBSERVATIONS RECEIVED DURING NOVEMBER, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R FOR	T HOR	R TAU	R RET	R ORI	T ORI
022426	*025751*	042209	*043263*	045307	*053005a*
508 11.0 Bl	525 12.0 Dr	539 8.2 Ch	514 8.7 En	564 10.2 Sp	528 10.1 L
517 10.0 Bl	528 12.5 Dw	540 8.5 Pt	515 8.4 Ht	R LEP	529 10.3 L
U CET	528 12.3 Dr	555 8.5 Hu	517 8.7 Bl	*045514*	531 10.3 L
022813	U ARI	560 8.7 B	525 7.4 Dr	522 6.4 L	533 10.1 L
526 8.2 Ch	030514	562 9.2 Sp	528 7.5 Dr	531 6.1 L	534 10.1 L
541 8.7 Gy	511 12.0 Bf	W TAU	528 7.5 Dw	539 6.2 L	535 10.2 L
556 9.5 Pt	539 13.1 Ch	042215	537 7.5 Dr	540 6.2 Pt	538 10.2 L
557 9.2 Sc	540 13.1 Sf	540 10.8 Pt	X CAM	546 6.5 L	539 10.1 L
RR CEP	555 13.3 Sf	551 10.8 Gi	043274	554 7.5 Wb	540 10.0 L
022980	560 13.3 Sf	560 10.7 Sc	491 11.2 Br	557 6.9 Sc	540 9.7 Pt
526 12.8 L	560 13.6 B	560 10.2 B	494 10.9 Br	V ORI	541 10.0 L
534 13.0 L	X CET	564 10.7 Gi	495 10.9 Br	050003	543 10.2 L
539 13.0 Ch	*031401*	S TAU	497 10.8 Br	540 11.0 Pt	544 10.2 L
540 12.9 L	523 10.7 L	042309	499 10.7 Br	554 12.5 Lg	544 10.2 Pt
540 12.8 Sf	531 10.1 L	539 12.0 Ch	500 10.7 Br	T LEP	545 10.0 L
547 12.4 L	539 9.8 L	560[13.0 B	502 10.5 Br	*050022*	546 10.2 L
551 12.2 Sf	540 10.2 Pt	T CAM	503 10.4 Br	508 11.5 Bl	547 10.1 L
556 10.9 Pt	546 9.6 L	043065	506 10.3 Br	511 12.0 Bf	548 10.1 L
560 11.7 Sf	555 9.4 Wy	491 8.5 Br	508 10.2 Br	540 11.6 Pt	550 10.1 Pt
R TRI	Y PER	494 8.5 Br	511 9.8 Br	S PIC	551 10.2 L
023133	032043	495 8.6 Br	517 8.7 Br	*050848*	562 11.0 Sp
523 9.0 Ah	540 8.0 Pt	497 8.7 Br	523 8.0 Br	508 8.6 Bl	564 10.9 Sp
525 9.2 Ah	555 8.2 Hu	500 8.9 Br	524 7.7 Br	R AUR	564 10.9 Gi
526 9.6 Ch	R PER	502 8.8 Br	525 7.6 Br	050953	AN ORI
530 9.6 Sw	032335	503 8.9 Br	533 7.5 Br	539 12.9 Ch	*053005t*
532 9.3 Ah	540 12.2 Pt	506 9.0 Br	535 7.5 Br	540 12.1 Pt	521 11.5 L
534 9.4 Jo	553 10.0 Lg	508 9.0 Br	540 7.3 Pt	T PIC	522 11.7 L
537 9.6 Sf	555 10.3 Wy	511 9.1 Br	554 8.1 Br	*051247*	527 11.8 L
540 9.5 Ah	T FOR	517 9.4 Br	560 8.3 B	508 13.0 Bl	528 11.8 L
541 9.8 Jo	*032528*	523 8.8 L	R DOR	525 13.5 Dr	529 11.7 L
541 9.4 Gy	522 8.6 L	523 9.4 Br	*043562*	NOV TAU	531 11.6 L
544 9.7 Wd	529 8.5 L	524 9.4 Br	498 5.5 En	051316	534 11.2 L
551 10.5 Sf	539 8.8 L	525 9.5 Br	500 5.5 Ht	528 13.6 L	538 11.7 L
555 9.8 Hu	546 9.6 L	533 9.7 Br	507 5.5 Ht	538 13.2 L	539 11.8 L
556 9.9 Pt	U ERI	534 8.6 L	508 5.4 Bl	T COL	540 11.8 L
560 10.7 Sf	*034625*	535 9.7 Br	514 5.5 En	*051533*	541 11.7 L
W PER	525 10.9 Dr	540 9.8 L	515 5.5 Ht	508 9.5 Bl	543 11.8 L
024356	530 10.6 Dw	540 10.1 Pt	517 5.5 Bl	525 10.3 Dr	544 11.9 L
540 10.8 Pt	530 10.7 Dr	547 9.3 L	525 5.1 Dr	537 11.1 Dr	545 11.8 L
547 10.7 Wy	537 10.1 Dr	553 10.2 Lg	531 5.5 Dr	S AUR	546 11.8 L
551 10.8 Gi	X PER	557 10.4 Wy	532 5.7 Dr	052034	547 11.7 L
555 10.0 Hu	034930	SZ TAU	537 5.4 Dr	557 11.5 Sp	548 11.7 L
555 11.0 Wy	525 11.8 Dr	043118	R CAE	564 11.5 Sp	551 11.6 L
557 10.8 Wy	531 12.2 Dr	540 10.2 Sf	*043738*	W AUR	S CAM
557 10.9 Sc	537 12.3 Dr	555 10.3 Sf	508 9.6 Bl	052036	053068
564 10.7 Cl	W ERI	560 10.2 Sf	525 10.2 Dr	539 14.2 L	540 10.5 Pt
R HOR	*040725*	RX TAU	537 10.5 Dr	546 14.1 L	RU AUR
025050	525 12.4 Dr	043208	R PIC	555 12.3 Sf	053337
495 12.8 Ht	537 12.2 Dr	540 10.0 Pt	*044349*	560 12.3 Sf	540[12.0 Pt
507 13.0 Ht	RY CAM	560 10.2 B	508 7.8 Bl	S ORI	555[14.0 Lg
508 13.1 Bl	042164	560 10.4 Sc	517 8.5 Bl	*052404*	564[13.4 Gi
525 13.3 Dr	523 8.0 Br	R RET	525 8.9 Dr	540 12.6 Pt	U AUR
528 13.2 Dw	524 7.9 Br	*043263*	537 9.3 Dr	T ORI	053531
531 13.4 Dr	525 7.9 Br	498 10.4 En	V TAU	*053005a*	555 12.9 Sf
537 13.0 Dr	533 7.9 Br	500 10.4 Ht	044617	521 10.2 L	560 12.9 Sf
T HOR	535 7.9 Br	506 10.0 En	554 11.7 Lg	522 10.1 L	SU TAU
025751	554 8.2 Br	507 9.9 Ht	560 10.0 B	523 10.1 L	054319
508 11.7 Bl		508 9.7 Bl		527 10.2 L	521 9.6 L

VARIABLE STAR OBSERVATIONS RECEIVED DURING NOVEMBER, 1928.

J.D.Est.Obs.

SY TAU
054319
522 9.6 L
523 9.5 L
527 9.4 L
528 9.6 L
529 9.4 L
531 9.6 L
533 9.5 L
534 9.4 L
535 9.6 L
538 9.5 L
538 9.8 Ch
539 9.5 L
540 9.5 L
540 9.6 Pt
540 9.7 Sf
541 9.4 L
543 9.4 L
544 9.5 L
544 9.6 Pt
545 9.4 L
547 9.5 L
550 9.7 Pt
551 9.5 L
555 9.6 Pt
555 9.7 Sf
557 9.8 Sp
560 10.3 Sf
562 10.6 Sf
S COL
054331
508 12.5 Bl
Z TAU
054615a
560 13.9 Sf
R COL
054629
508[13.0 Bl
525[13.0 Dr
537[13.5 Dr
α ORI
054907
521 0.9 L
522 0.9 L
527 0.7 L
529 0.8 L
534 0.8 L
538 0.8 L
539 0.7 L
545 0.7 L
U ORI
054920a
523 6.2 Ah
525 6.2 Ah
532 6.0 Ah
540 6.1 Ah
540 6.1 Pt
543 5.3 Ah
546 6.4 Ah

J.D.Est.Obs.

U ORI
054920a
547 6.4 Ah
549 6.4 Ah
550 6.5 Ah
557 6.6 Sc
557 6.6 Wd
562 6.5 Wd
564 6.6 Wd
568 6.6 Wd
V CAM
054974
540 13.8 Sf
555 12.2 Sf
560 11.9 Sf
Z AUR
055353
491 10.4 Br
494 10.5 Br
495 10.5 Br
496 10.5 Br
497 10.5 Br
500 10.6 Br
502 10.5 Br
503 10.6 Br
504 10.6 Br
506 10.6 Br
507 10.6 Br
508 10.7 Br
510 10.7 Br
511 10.8 Br
512 10.8 Br
517 10.7 Br
523 10.7 Br
524 10.7 Br
525 10.7 Br
533 10.6 Br
535 10.7 Br
540 10.0 Pt
544 10.2 Pt
554 10.7 Br
555 9.8 Pt
556 9.9 Pt
558 9.9 Pt
562 9.9 Pt
R OCT
055686
496 11.0 En
506 11.0 En
508 11.4 Bl
526 11.6 Dr
X AUR
060450
540 9.1 Pt
560 9.4 Sc
V AUR
061647
535 9.9 L
543 9.7 L
554 10.6 Lg

J.D.Est.Obs.

V AUR
061647
557 11.1 Sp
V MON
061702
540 6.9 Pt
— AUR
062047
521 10.1 L
527 10.2 L
529 10.4 L
534 10.5 L
539 10.7 L
543 10.7 L
546 10.6 L
R MON
063308
540 10.8 Pt
S LYN
063558
540 14.3 Pt
560 13.9 Sf
X GEM
064030
515 9.9 Bn
566 8.4 Bw
W MON
064707
540 9.5 Pt
X MON
065208
522 7.8 L
531 7.9 L
539 7.8 L
547 7.9 L
R LYN
065355
523 8.8 Ah
525 8.9 Ah
532 9.2 Ah
540 9.3 Ah
V CMI
070109
516 8.5 Ch
R GEM
070122a
532 11.5 Ah
540 9.6 Pt
562 8.6 Wd
562 8.2 Sp
564 8.0 Sp
568 8.4 Wd
Z GEM
070122b
540 12.5 Pt
TW GEM
070122c
540 7.9 Pt

J.D.Est.Obs.

R CMI
070310
522 8.2 L
532 8.5 L
539 8.3 L
547 8.4 L
R VOL
070772
525 10.2 Dr
537 10.3 Dr
L_2 PUP
071044
525 3.4 Dr
537 3.5 Dr
RR MON
071201
516[11.3 Ch
V GEM
071713
540 12.6 Pt
S CMI
072708
512 8.3 Ch
540 7.5 Pt
S VOL
073173
508[13.2 Bl
525 13.4 Dr
U CMI
073508
522 8.9 L
532 9.2 L
539 9.1 L
540 9.5 Pt
547 9.6 L
S GEM
073723
512 12.7 Ch
W PUP
074241
508 11.7 Bl
T GEM
074323
510 9.0 Ch
514 9.8 Ch
540 12.5 Pt
R CNC
081112
514 10.6 Ch
540 10.8 Pt
V CNC
081617
510 8.4 Br
511 8.4 Br
535 8.4 Br
538 8.2 Ch
540 8.0 Pt
554 8.5 Br

J.D.Est.Obs.

RT HYA
082405
540 7.5 Pt
R CHA
082476
508[12.6 Bl
X UMA
083350
540 11.0 Pt
S HYA
084803
514 7.8 Ch
540 8.5 Pt
T HYA
085008
514 7.8 Ch
522 7.8 L
532 8.0 L
539 8.1 L
540 7.8 Pt
547 8.2 L
T CNC
085120
538 9.1 Ch
540 8.0 Pt
V UMA
090151
527 9.7 L
535 9.9 L
543 10.1 L
W CNC
090425
529 13.1 L
539 13.1 L
546 13.2 L
RX UMA
090567
527 11.2 L
532 10.9 L
538 10.9 L
545 11.3 L
RW CAR
091868
490 11.8 Bl
497 11.2 Bl
507 10.0 Bl
516 9.8 Bl
526 9.6 Dr
537 9.6 Dr
R CAR
092962
490 9.2 Bl
497 9.5 Bl
507 9.0 Bl
516 9.1 Bl
525 9.3 Dr
537 9.1 Dr
X HYA
093014
538[11.0 Ch

J.D.Est.Obs.

R LMI
093934
514 10.8 Ch
538 11.5 Ch
540 11.6 Pt
R LEO
094211
514 6.1 Ch
540 6.4 Pt
Z VEL
094953
490 10.2 Bl
497 10.2 Bl
508 10.4 Bl
525 10.7 Dr
537 11.1 Dr
V LEO
095421
539 12.2 Ch
540 12.4 Pt
RV CAR
095563
497[13.1 Bl
S CAR
100661
490 5.5 Bl
497 5.0 Bl
507 5.2 Bl
516 5.0 Bl
525 5.7 Dr
537 6.4 Dr
Z CAR
101058a
497[12.6 Bl
525 12.6 Dr
537 11.7 Dr
AF CAR
101058b
525 10.1 Dr
537 10.7 Dr
U HYA
103212
538 5.0 L
543 4.0 L
546 4.9 L
547 4.9 L
RZ CAR
103270
525[13.6 Dr
R UMA
103769
539 13.2 Ch
540 12.6 Pt
V HYA
104620
532 7.1 L
543 7.3 L
RY CAR
111561
497[13.1 Bl

VARIABLE STAR OBSERVATIONS RECEIVED DURING NOVEMBER, 1928.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
RS CEN			U OCT			RX CEN			S BOO			S CRB			U LIB		
111661			*131283*			*134536*			141954			151731			*153620a*		
497	9.7	Bl	495	9.6	Ht	498[	13.1	Bl	521	10.3	L	511	9.9	Ch	490	11.6	Bl
497	9.2	Bl	497	9.4	Bl	T APS			527	10.3	Ch	527	8.6	Ch	498	11.0	Bl
507	8.8	Bl	500	9.4	Ht	*134677*			532	10.2	Pt	532	7.7	Pt	508	10.3	Bl
516	9.0	Bl	501	9.0	En	490	12.3	Bl	534	10.9	L	551	7.2	Sb	516	10.1	Bl
527	8.0	Dr	507	9.0	Ht	498	12.5	Bl	541	10.9	L	559	6.3	Sb	T NOR		
537	8.1	Dr	507	8.8	Bl	506[	12.3	En	542	11.3	L	567	7.0	Sb	*153654*		
X CEN			511	8.5	Dr	525	13.2	Dr	RS VIR			RS LIB			494	10.2	En
114441			514	8.4	En	RU HYA			142205			*151822*			495	10.7	Ht
497[	12.2	Bl	515	8.8	Ht	*140528*			462	13.8	Bf	490	10.8	Bl	499	10.4	En
W CEN			516	8.6	Bl	490[	12.9	Bl	471	14.2	Bf	494	11.3	En	500	10.8	Ht
115058			525	8.7	Dr	494[	12.5	En	V BOO			495	11.7	Ht	507	11.1	Ht
490	9.2	Bl	528	8.6	Dr	498	13.3	Bl	142539a			498	11.2	Bl	515	11.4	Ht
494	9.6	En	537	8.6	Dr	508	12.4	Bl	511	8.0	Ch	500	11.5	Ht	521	11.3	Dr
495	9.4	Ht	R HYA			516	11.3	Bl	532	8.0	Pt	501	11.4	En	526	12.0	Dr
497	9.3	Bl	*132422*			518	11.0	Dr	R BOO			507	11.3	Ht	531	12.2	Dr
500	9.5	Ht	490	5.8	Bl	526	10.0	Dr	143227			508	11.0	Bl	Z LIB		
507	9.5	Ht	494	6.2	En	R CEN			511	6.8	Ch	515	11.2	Ht	*154020*		
507	9.6	Bl	501	5.0	En	*140959*			521	6.7	Lj	516	11.5	Bl	498[	13.0	Bl
516	11.0	Bl	508	4.5	Bl	490	8.7	Bl	524	6.8	Lj	R NOR			R CRB		
R CRV			514	4.3	En	494	9.6	En	527	7.0	Ch	*152849*			154428		
121418			S VIR			495	9.9	Ht	532	6.8	Pt	490	9.8	Bl	511	6.1	Ch
471	14.1	Bf	*132706*			497	9.0	Bl	534	7.9	Lj	494	10.3	En	521	6.0	L
SS VIR			349	9.2	Wb	499	9.6	En	535	8.0	Lj	498	10.2	Bl	521	6.2	Lj
122001			RV CEN			500	10.1	Ht	540	8.0	Lj	499	10.4	En	522	6.2	Lj
538	6.0	L	*133155*			507	10.5	Ht	543	8.1	Lj	508	10.6	Bl	523	6.0	Ah
546	6.2	L	490	8.4	Bl	508	9.9	Bl	546	8.2	Lj	514	10.9	En	524	6.2	Lj
T CVN			497	8.7	Bl	514	9.9	En	Y LUP			516	10.7	Bl	524	6.0	Ch
122532			507	8.8	Bl	515	10.5	Ht	*145254*			521	10.9	Dr	525	6.0	L
540	11.1	Pt	516	9.0	Bl	516	9.9	Bl	490	10.8	Bl	526	11.2	Dr	525	6.0	Ah
Y VIR			518	8.7	Dr	525	9.8	Dr	494	10.9	En	X LIB			527	6.0	L
122803			T UMI			528	10.2	Dr	498	10.8	Bl	*153020*			527	6.2	Lj
462	11.6	Bf	133273			U UMI			499	10.9	En	490	10.5	Bl	528	6.2	Lj
471	10.7	Bf	544	10.2	Sc	141567			508	10.7	Bl	498	10.8	Bl	529	6.0	L
U CEN			T CEN			467	7.5	Wb	514	10.9	En	508	11.3	Bl	530	5.9	L
122854			*133633*			483	7.5	Wb	516	10.8	Bl	516	11.3	Bl	531	6.0	L
490	12.0	Bl	490	6.5	Bl	511	7.7	Ch	521	10.8	Dr	W LIB			532	6.1	L
497	12.4	Bl	494	6.3	En	521	8.4	Lj	525	10.8	Dr	*153215*			532	6.1	Pt
T UMA			495	6.2	Ht	523	8.5	Ah	S APS			498	11.5	Bl	532	6.1	Sw
123160			497	6.3	Bl	524	8.5	Lj	*145071*			508	11.3	Bl	534	6.1	L
540	11.9	Pt	499	6.5	En	524	8.4	Ch	490[	13.4	Bl	516	11.3	Bl	534	6.2	Lj
RS UMA			500	6.2	Ht	525	8.7	Ah	495[	13.4	Ht	S UMI			535	6.2	Lj
123459			507	6.2	Ht	527	8.8	Lj	498[	14.0	Bl	153378			535	6.0	L
462	13.7	Bf	507	6.3	En	532	8.8	Ah	500[	13.4	Ht	511	8.8	Ch	538	6.1	Ch
471	13.6	Bf	507	6.5	Bl	532	8.0	Pt	507[	13.4	Ht	521	8.7	Lj	539	6.1	Ah
540	9.2	Pt	515	6.2	Ht	533	9.1	Lj	508[	13.4	Bl	524	8.6	Lj	540	6.2	Lj
S UMA			516	6.0	Bl	535	9.1	Lj	516[	13.4	Bl	527	8.7	Lj	540	6.3	Sb
123961			RT CEN			540	9.2	Lj	Y LIB			532	8.4	Pt	543	6.2	Sb
467	9.3	Wb	*134236*			540	8.9	Ah	*150605*			533	8.7	Lj	543	6.2	Lj
521	11.6	Lj	490	9.9	Bl	543	9.2	Lj	525	8.3	L	535	8.7	Lj	543	6.0	L
533	11.8	Lj	494	9.6	En	546	9.2	Lj	531	8.2	L	538	8.6	Ch	543	6.1	Ah
535	11.9	Lj	495	9.8	Ht	547	9.3	Ah	S SER			540	8.7	Lj	544	6.1	Wd
540	11.8	Lj	497	10.0	Bl	549	9.5	Lj	151714			541	8.5	Gy	544	6.2	Lj
540	11.4	Pt	499	10.0	En	549	9.5	Ah	525	8.3	L	543	8.7	Lj	544	6.2	Pt
543	11.4	Lj	500	10.0	Ht	550	9.3	Ah	532	8.6	Pt	544	8.7	Sc	545	6.1	Pt
U OCT			507	10.0	Ht	564	9.4	Cl	534	8.7	L	545	8.7	Lj	546	6.0	L
131283			507	10.2	Bl	S BOO			540	8.9	L	547	8.7	Lj	546	6.2	Lj
490	10.3	Bl	516	10.2	Bl	141954			551	9.0	L	549	8.7	Lj	548	6.2	Lj
494	9.9	En	518	10.1	Dr	511	9.8	Ch				557	8.6	Sc	549	6.1	Pt

VARIABLE STAR OBSERVATIONS RECEIVED DURING NOVEMBER, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R CrB	X Sco	W CrB	W Her	RS Sco	Z Oph
154428	*160221a*	161138	163137	*164844*	171401
550 6.0 L	498 11.1 Bl	532 11.2 Pt	517 11.4 Br	507 7.1 Ht	552 8.3 Lg
550 6.1 Sp	516 10.8 Bl	557 10.0 Sp	524 11.7 Ch	508 6.9 Bl	557 9.0 Sp
550 6.1 Ah	SX Her	564 9.2 Sp	524 11.9 Br	511 6.9 Dr	RS Her
550 6.1 Sb	160325	W Oph	525 11.9 Br	515 7.1 Ht	171723
551 6.1 Pt	491 8.1 Br	*161607*	532 12.3 Pt	516 7.1 Bl	532 10.7 Pt
551 6.2 Wd	495 8.2 Br	531 12.5 L	534 12.7 Br	525 6.8 Dr	552 9.4 Lg
551 6.0 L	503 8.4 Br	V Oph	R Dra	528 7.2 Dr	S Oct
554 6.2 Sb	504 8.4 Br	*162112*	163266	531 7.2 Dr	*172486*
555 6.2 Pt	507 8.5 Br	524 9.8 Ch	511 10.7 Ch	532 7.3 Dw	495 9.7 Ht
556 6.1 Pt	508 8.5 Br	531 9.6 L	521 9.8 Ah	537 7.2 Dr	495 9.5 En
557 6.1 Pt	517 8.8 Br	532 8 7 Pt	521 10.0 Lj	RR Sco	498 9.7 Bl
558 6.2 Pt	522 8.5 L	U Her	523 9.9 Ah	*165030*	500 10.0 Ht
559 6.3 Sb	524 8.7 Br	162119	524 9.9 Lj	491 11.3 Bl	503 10.1 En
561 6.1 Pt	525 8.8 Br	521 7.4 Ah	525 9.8 Ah	494 11.2 En	507 10.2 Ht
562 6.1 Pt	530 9.0 Br	523 7.6 Ah	527 9.8 Lj	495 11.5 Ht	508 10.0 Bl
562 6.1 Gy	532 9.0 L	524 7.4 Ch	532 9.5 Ah	498 10.9 Bl	511 10.1 Dr
565 6.3 Sb	532 8.5 Pt	525 7.7 Ah	532 9.6 Pt	500 11.5 Ht	514 10.3 En
568 6.2 Sb	540 8.4 L	532 7.8 Ah	533 9.7 Lj	501 10.8 En	515 10.6 Ht
V CrB	544 8.3 Pt	532 8.0 Sw	534 8.9 Jo	507 11.0 Ht	516 10.4 Bl
154639	545 8.5 Pt	532 7.0 Pt	535 9.7 Lj	508 10.2 Bl	525 11.2 Dr
532 7.0 Pt	547 8.2 L	539 8.0 Ah	538 9.2 Ch	515 10.3 Ht	532 11.5 Dr
R Lup	549 8.8 Pt	540 8.0 Ah	539 9.1 Hs	516 9.1 Bl	532 11.6 Dw
154736	551 8.0 Pt	543 7.8 Ah	540 9.2 Lj	521 8.6 Dr	RU Oph
494 10.5 En	555 8.5 Pt	547 7.9 Ah	541 8.8 Jo	525 8.4 Dr	172809
499 10.2 En	556 8.3 Pt	549 8.0 Ah	543 9.1 Lj	528 8.3 Dr	532 12.2 Pt
525 10.1 Dr	557 8.5 Pt	550 8.1 Ah	544 9.1 Lj	531 7.9 Dr	RT Ser
528 10.1 Dr	561 8.1 Pt	558 8.1 Hs	547 8.9 Lj	532 7.8 Dw	*173212*
RR Lib	562 8.5 Pt	560 8.8 Hs	547 8.8 Ah	537 7.9 Dr	531 11.3 L
155018	W Sco	SS Her	549 8.8 Ah	SS Oph	540 12.0 L
524 10.1 Ch	*160519*	162807	550 8.7 Ah	*165202*	551 12.0 L
529 9.9 L	490 12.1 Bl	527 13.1 L	556 7.8 B	532 13.5 Pt	RU Sco
RZ Sco	498 13.0 Bl	532 12.5 Pt	557 8.3 Hs	RT Sco	*173543*
155823	RU Her	534 12.8 L	569 7.4 Hs	*165636*	498 9.0 Bl
494 9.0 En	160625a	540 12 0 Kz	RR Oph	498[14.0 Bl	508 8.8 Bl
495 8.9 Ht	491 8.4 Br	540 11.9 Eb	*164310*	R Oph	516 8.7 Bl
500 9.1 Ht	495 8.5 Br	542 11.8 L	494[12.0 En	*170215*	SV Sco
501 8.8 En	503 8.9 Br	T Oph	501[12.0 En	511 8.0 Ch	*174135*
507 8.8 Ht	504 8.9 Br	*162815*	S Her	532 8.0 Pt	498 9.7 Bl
515 9.1 Ht	507 9.0 Br	498[12.8 Bl	164715	539 8.3 Ch	508 9.8 Bl
Z Sco	508 9.0 Br	531 13.3 L	521 8.1 Ah	RT Her	516 9.9 Bl
160021	517 9.2 Br	531 11.3 L	523 8.0 Ah	170627	W Pav
490 10.0 Bl	522 9.4 L	540 12.0 L	525 8.0 Ah	532 12.6 Pt	*174162*
494 10.3 En	532 10.1 L	551 12.0 L	532 7.9 Ah	RW Sco	494[12.3 En
495 10.1 Ht	532 9.8 Pt	S Oph	532 7.6 Pt	*170833*	495[13.0 Ht
498 9.8 Bl	534 9.8 Sp	*162816*	539 8.1 Ah	491 10.4 Bl	498 13.0 Bl
500 10.1 Ht	538 10.3 Ch	490 11.0 Bl	540 7.9 Ah	498 10.4 Bl	500[13.0 Ht
501 10.0 En	540 9.9 L	498 11.7 Bl	543 7.9 Ah	508 10.6 Bl	501[12.3 En
507 10.0 Ht	547 10.2 L	508 12.5 Bl	547 7.9 Ah	516 10.5 Bl	507[13.0 Ht
508 9.6 Bl	R Sco	W Her	549 7.8 Ah	Z Oph	RS Oph
515 9.6 Ht	*161122a*	163137	550 7.8 Ah	171401	174406
516 9.4 Bl	462 11.6 Bf	491 9.5 Br	RS Sco	523 8.3 Ah	532 11.1 Pt
531 9.5 L	471 11.8 Bf	495 9.7 Br	*164844*	525 8.5 Ah	U Ara
U Ser	498 14.2 Bf	497 10.1 Br	490 7.1 Bl	532 8.4 Ah	*174551*
160210	S Sco	503 10.5 Br	494 7.5 En	532 8.5 Pt	495 11.3 En
532 13.0 Pt	*161122b*	504 10.6 Br	495 7.2 Ht	539 8.8 Ah	506 12.1 En
X Sco	462 11.2 Bf	507 11.2 Br	498 6.6 Bl	540 8.7 Ah	T Dra
160221a	471 11.4 Bf	508 11.4 Br	500 7.2 Ht	543 8.9 Ah	175458a
490 10.9 Bl	498[14.2 Bf	511 11.2 Ch	501 7.3 En	550 9.0 Ah	537 11.0 Ch

VARIABLE STAR OBSERVATIONS RECEIVED DURING NOVEMBER, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
UY DRA	X DRA	RV LYR	RW LYR	R AQL	RY SGR
175458b	180666	184134	184243	190108	*191033*
537[12.3 Ch	556[13.0 B	532 12.8 Pt	540 13.7 B	532 10.8 Ah	495 6.5 Ht
RY HER	560 11.1 Sc	540 13.1 Kz	NOV AQL	540 11.1 B	495 6.0 En
175519	TV HER	540 13.2 Eb	184300	V LYR	498 6.0 Bl
511 9.1 Ch	181031	R SCT	524 10.7 Ch	190529a	500 6.3 Ht
524 9.6 Ch	522 11.9 L	*184205*	544 11.3 Pt	531 13.3 B	501 6.5 En
532 9.9 Pt	532 12.7 L	511 5.6 Ch	551 11.1 Pt	540[13.0 Eb	507 6.5 Ht
539 10.8 Ch	542 13.5 L	521 5.0 Lj	552 10.9 Lg	559 12.3 B	508 6.4 Bl
540 11.2 Kz	550[12.5 L	521 5.2 L	553 10.8 Lg	RX SGR	514 6.8 En
540 10.9 Eb	RY OPH	522 5.6 Ch	554 10.8 Lg	*190818*	515 6.5 Ht
V DRA	181103	522 4.9 Lj	555 10.8 Lg	498 11.0 En	517 6.0 Bl
175654	523 9.2 Ah	527 5.3 Lj	555 11.6 Pt	506 11.6 En	521 6.5 L
532 10.0 Pt	525 9.4 Ah	527 5.4 Ch	557 11.0 Sp	536 11.4 Ch	521 6.6 Dr
540 10.3 Kz	532 10.1 Ah	531 5.0 L	558 10.8 Lg	552 11.2 Lg	522 6.5 L
540 10.4 Eb	532 9.8 Pt	532 5.0 L	561 11.3 Pt	RW SGR	525 6.6 Dr
R PAV	W LYR	532 5.2 Pt	564 11.0 Sp	*190819a*	526 6.6 Dr
180363	181136	532 4.9 Sw	RX LYR	498 9.6 En	527 6.5 L
494 10.3 En	526 9.7 Sw	533 5.6 Lg	185032	506 9.7 En	528 6.5 L
495 10.4 Ht	532 9.5 Sw	534 5.0 Jo	536[13.0 Ch	536 9.7 Ch	528 6.7 Dr
500 10.4 Ht	532 9.3 Pt	534 5.0 Lj	540[13.0 Eb	551 9.7 Pt	531 6.8 Dr
501 10.6 En	540 9.3 B	535 5.6 Lj	S CRA	552 9.6 Lg	531 6.6 L
507 11.2 Ht	549 9.1 Sw	538 5.3 Ch	*185437a*	TY AQL	532 6.7 L
511 11.4 Dr	555 9.0 Sw	540 5.2 L	498 11.9 Bl	190907	532 6.7 Dr
515 11.5 Ht	RV SGR	540 5.1 Lj	508 12.5 Bl	551 10.6 Pt	532 6.3 Dw
521 12.1 Dr	*182133*	541 5.2 Sw	516 11.8 Bl	S LYR	532 6.3 Pt
T HER	498 8.2 Bl	541 5.3 Jo	ST SGR	190925	534 6.6 L
180531	508 8.4 Bl	541 5.3 Sc	*185512a*	528 14.5 L	535 6.6 L
511 7.7 Ch	516 8.6 Bl	542 5.3 L	522 11.8 L	536[13.1 Ch	539 6.0 Ch
521 8.0 Ah	521 8.6 Dr	543 5.6 Lj	532 11.9 L	540 15.0 L	542 6.5 L
522 8.1 L	525 8.7 Dr	544 5.6 Lj	536 12.3 Ch	558[13.1 Wy	544 6.4 Pt
523 8.2 Ah	528 9.0 Dr	544 5.3 Pt	542 12.3 L	X LYR	545 6.5 Pt
525 8.5 Ah	532 9.6 Dw	544 5.1 Wd	552[13.0 Lg	190926	546 6.5 L
532 8.8 Sw	537 9.6 Dr	544 5.2 Sc	R CRA	551 8.9 Pt	547 6.5 L
532 8.7 Ah	SV HER	545 5.4 Pt	*185537a*	RS LYR	549 6.4 Pt
532 8.6 Pt	182224	545 5.6 L	498 12.8 Bl	190933a	550 6.5 L
532 8.5 L	522 13.6 L	546 5.7 Lj	508 11.9 Bl	524 12.0 Ch	551 6.5 L
534 8.7 Jo	532 12.8 L	548 5.6 Lj	516 11.0 Bl	551 13.5 Pt	551 6.4 Pt
539 9.0 Ah	540 11.4 B	549 5.0 Pt	T CRA	RU LYR	555 6.3 Pt
539 8.8 Ch	542 11.3 L	549 5.7 Sw	*185537b*	190941	557 6.4 Pt
540 9.2 Ah	550 10.6 L	550 5.6 Sp	498 13.3 Bl	551 11.5 Pt	558 6.4 Pt
540 9.5 Kz	T SER	550 5.6 L	Z LYR	552 11.7 Lg	561 6.3 Pt
540 9.5 Eb	182306	551 5.0 Pt	185634	U DRA	562 6.4 Pt
541 9.2 Sc	532 9.3 Pt	551 5.6 Wd	527 14.5 L	190967	TV SGR
542 9.0 L	534 10.1 Sp	552 6.2 Lg	528 14.5 L	536 12.3 Ch	*191124*
543 9.3 Ah	552 11.3 Lg	553 6.0 Lg	540 14.2 L	551 12.5 Pt	494 12.4 En
544 9.5 Sc	557 11.1 Sp	554 6.0 Lg	540 13.7 B	569 11.0 Hu	498 12.8 Bl
549 9.5 Sw	X OPH	555 6.1 Lg	547 13.8 L	W AQL	501[12.2 En
549 9.2 Ah	183308	555 5.5 Sp	RT LYR	*191007*	525 13.5 Dr
550 9.8 Ah	397 8.4 Wb	555 5.5 Pt	185737	536 12.3 Ch	532[12.4 Dw
550 9.6 L	467 7.6 Wb	556 5.4 Pt	524 11.3 Ch	T SGR	S SGR
555 9.7 Sw	522 6.6 L	557 5.5 Pt	540 12.7 Kz	*191017*	*191319a*
560 11.0 Hs	532 6.9 L	557 6.0 Wd	540 12.6 Eb	536 8.4 Ch	498 10.6 Bl
W DRA	532 6.5 Pt	558 6.0 Lg	R AQL	551 8.1 Pt	508 10.9 Bl
180565	534 7.5 Jo	558 5.6 Pt	190108	R SGR	517 11.4 Bl
532 11.8 Pt	541 7.7 Jo	561 5.9 Pt	511 10.2 Ch	*191019*	SW SGR
556 9.9 B	542 7.0 L	562 5.9 Pt	523 10.6 Ah	536 12.4 Ch	*191331*
560 9.8 Sc	550 7.2 L	562 5.5 Sp	525 10.7 Ah	551 11.5 Pt	498[12.9 Bl
		562 5.6 Gy	527 10.7 Ch		
		564 5.7 Sp	532 9.8 Pt		

Variable Star Observations Received During November, 1928.

J.D.Est.Obs.

TZ Cyg
191350
551 10.8 Pt
562 10.5 Sp

U Lyr
191637
551 11.0 Pt

AF Cyg
192745
491 7.2 Br
495 7.3 Br
500 7.3 Br
502 7.3 Br
503 7.3 Br
506 7.4 Br
512 7.4 Br
524 7.4 Br
525 7.4 Br
533 7.3 Br
534 7.2 Br

TY Cyg
192928
537 13.3 Ch
551 13.0 Pt

RT Aql
193311
524 10.3 Ch
546 8.4 B
551 8.1 Pt
553 8.6 Lg

R Cyg
193449
349 7.4 Wb
388 8.6 Wb
397 8.4 Wb
412 9.4 Wb
534 12.8 Ch
555 13.3 Pt
559 13.3 B

RV Aql
193509
553 10.5 Lg
555 10.0 Pt

TT Cyg
193732
569 7.5 Hu

T Pav
193972
495 8.3 Dr
503 8.3 En
511 8.3 Dr
525 8.4 Dr
531 8.6 Dr
532 8.6 Dw
537 8.6 Dr

RR Sgr
194029
498 9.6 Bl
508 10.4 Bl
517 10.6 Bl
525 10.6 Dr
531 11.0 Dr
532 10.7 Dw

J.D.Est.Obs.

T Pav
193972
528 8.8 Dr
532 9.0 Dw
537 9.4 Dr

RT Cyg
194048
523 9.0 Ah
524 9.1 Ch
527 8.8 Wb
532 8.5 Ah
534 8.4 Jo
534 8.4 Ch
540 8.2 Ah
541 8.0 Jo
543 8.1 Ah
547 7.6 Ah
549 7.5 Ah
550 7.4 Ah
555 7.1 Pt
557 6.9 Sc
559 7.3 B
560 6.9 Sc
562 7.5 Jo
562 7.2 Wb
569 7.0 Hu

TU Cyg
194348
534 12.8 Ch
555 13.6 Pt
559 13.1 B

X Aql
194604
529 10.7 B
555 9.0 Pt
556 9.2 B

χ Cyg
194632
511 10.3 Ch
526 11.3 Sw
534 11.6 Sp
534 11.5 Ch
555 11.1 Pt

S Pav
194650
495 8.3 En
503 8.3 En
511 8.3 Dr
525 8.4 Dr
527 10.9 Lj
533 11.0 Lj
535 11.1 Lj
540 11.2 Lj
543 11.5 Lj
549 12.3 Lj

S Cyg
200357
534[12.8 Ch
560[14.0 B

J.D.Est.Obs.

RU Sgr
195142
495 12.5 Ht
498 13.0 Bl
500 12.8 Ht
507 12.5 Ht

RR Aql
195202
546 10.0 B
555 10.1 Pt
557 10.1 Sp

RS Aql
195308
546[12.3 B

Nov Cyg
195553
537[13.0 Ch
540[12.4 Pt
551[12.4 Pt
555[12.2 Pt
559[12.2 Pt

Z Cyg
195849
524 9.0 Ch
537 8.0 Ch
541 8.1 Sc
546 8.2 Sc
555 8.1 Pt
557 8.3 Sc
559 8.3 B
560 8.3 Sc

S Tel
195855
495[12.6 En
498 13.0 Bl
506[12.6 En

SY Aql
200212
528 13.4 L
540 12.9 L
545 12.4 L
553 11.6 Lg
555 11.1 Pt
557 11.6 B

BU Cyg
200250
521 10.7 Lj
524 10.8 Lj
527 10.9 Lj
533 11.0 Lj
535 11.1 Lj
540 11.2 Lj
543 11.5 Lj
549 12.3 Lj

S Cyg
200357
534[12.8 Ch
560[14.0 B

J.D.Est.Obs.

R Cap
200514
511 11.0 Ch
531 9.7 B
555 9.0 Pt
559 9.8 B

SV Cyg
200647
541 9.4 Sc
546 9.0 Sc
557 9.1 Sc

S Aql
200715a
491 11.2 Br
494 11.2 Br
495 11.2 Br
496 11.2 Br
497 11.1 Br
500 11.1 Br
502 11.1 Br
503 11.2 Br
504 11.1 Br
506 11.1 Br
508 11.2 Br
511 11.1 Br
511 11.5 Ch
512 11.1 Br
523 10.7 Br
524 10.6 Br
525 10.5 Br
530 10.1 Br
533 9.9 Br
534 9.6 Br
546 9.6 B
553 9.6 Lg
555 9.6 Pt

RW Aql
200715b
546 9.2 B
553 8.2 Lg
555 9.0 Pt

R Tel
200747
498 13.7 Bl
508 13.3 Bl

RU Aql
200812
528 13.5 L
529 13.4 B
540 14.0 L
551 13.7 L
557 13.8 B

W Cap
200822
498[13.3 Bl
555 12.1 Pt

Z Aql
200906
464 11.1 Bf
529 11.8 B

J.D.Est.Obs.

Z Aql
200906
555[12.8 Pt
557[13.6 B

R Sge
200916
546 9.5 B

RS Cyg
200938
356 8.8 Wb
511 7.4 Ch
512 8.0 Wb
519 7.1 Ch
522 7.0 Ch
524 6.9 Ch
526 6.8 Ch
527 7.6 Wb
528 7.3 L
532 7.3 Ch
533 7.5 Ch
534 7.3 Jo
535 7.7 Ch
536 7.2 Ch
537 7.2 Ch
540 7.2 L
541 7.3 Jo
541 7.1 Sc
545 7.2 L
546 7.0 Sc
555 7.0 Pt
557 7.0 Sc
557 7.2 Sp
558 7.4 Sb
560 7.0 Sc
562 7.2 Wb
562 7.2 Jo
564 7.2 Wd
564 7.2 Sp
566 7.5 Sb

R Del
201008
523 8.3 Ah
525 8.5 Ah
528 8.5 L
530 8.5 L
531 8.7 B
532 8.9 Ah
537 8.5 Ch
539 9.1 Ah
540 9.1 Ah
540 8.8 L
543 9.3 Ah
545 8.7 L
550 9.6 Ah
555 9.3 Pt
557 10.1 Sp
558 10.0 Wy
559 9.5 B

J.D.Est.Obs.

RT Cap
201121
555 6.6 Pt

SX Cyg
201130
555 12.6 Pt
556 12.2 B

RT Sgr
201139
498 10.8 Bl
508 10.7 Bl
517 10.4 Bl
526 10.6 Dr
531 10.3 Dr
537 9.9 Dr

WX Cyg
201437b
528 12.5 L
537 12.0 Ch
540 12.1 L
545 12.0 L
555 11.5 Pt
556 11.5 B
564 11.5 Sp

U Cyg
201647
512 8.5 Wb
512 9.4 Ch
527 10.4 Wb
532 10.4 Ch
534 9.0 Jo
541 9.8 Jo
544 9.9 Wd
555 8.8 Pt
556 9.8 B
557 10.2 Sp
560 10.5 Wd
562 10.0 Jo
562 9.4 Wb

U Mic
202240
498 9.9 Bl
508 10.5 Bl
517 10.5 Bl
525 10.5 Dr
531 10.5 Dr

SV Cyg
202247
569 8.0 Hu

RW Cyg
202539
541 9.4 Sc
546 9.7 Sc
557 9.4 Sc
560 9.4 Sc

RU Cap
202622
466 14.3 Bf
531[12.3 B
559[12.3 B

VARIABLE STAR OBSERVATIONS RECEIVED DURING NOVEMBER, 1928.

J.D.Est.Obs.

Z DEL
202817
531 11.4 B
555 10.3 Pt
ST CYG
202954
555 12.9 Pt
556 12.9 B
V VUL
203226
555 8.6 Pt
R MIC
203429
498[13.3 Bl
Y DEL
203611
553 13.4 B
559 13.4 B
S DEL
203816
521 12.0 Lj
524 12.0 Lj
527 12.0 Lj
533 12.0 Lj
535 11 9 Lj
540 11.9 Lj
543 11.8 Lj
544 11.8 Lj
547 11.7 Lj
555 10.1 Pt
557 10.2 B
557 10.9 Sc
V CYG
203847
519 10.0 Ch
529 13.7 B
534 11.0 Ch
555 9.5 Pt
556 12.7 B
Y AQR
203905
466 14.6 Bf
512 11.4 Ch
531 10.6 B
534 10.8 Sp
535 10.6 Ch
552 10.9 Lg
555 10.9 Pt
557 10.5 Sp
T DEL
204016
531[13.7 B
534[13.3 Ch
559[13.8 B
V AQR
204102
555 9.2 Pt
W AQR
204104
466 10.8 Bf

J.D.Est.Obs.

W AQR
204104
528 12.4 L
540 12.6 L
545 12.8 L
U CAP
204215
498 13.5 Bl
508 12.4 Bl
540 11.8 B
V DEL
204318
531[13.5 B
557[12.7 B
T AQR
204405
512 13.8 Ch
539 12.3 Ch
552 12.4 Lg
555 11.6 Pt
556 11.5 B
557 11.2 Sp
562 11.0 Sp
569 10.0 Hu
RZ CYG
204846
555 13.1 Pt
556 13.0 B
S IND
204954
498 11.8 Bl
508 12.3 Bl
525 13.4 Dr
528 13.4 Dr
X DEL
205017
531 10.3 B
555 11.7 Pt
557 11.4 B
569 11.7 Hu
RR CAP
205627
511 9.7 Dr
525 9.8 Dr
528 9.8 Dr
537 9.9 Dr
R VUL
205923a
523 8.6 Ah
525 8.7 Ah
532 9.0 Ah
534 9.1 Jo
540 9.5 Ah
543 9.8 Ah
546 9.5 Jo
555 10.7 Pt
558 11.1 Wy
559 10.8 B

J.D.Est.Obs.

RS CAP
210116
549 8.3 Sc
V CAP
210124
498 9.4 Bl
508 9.5 Bl
511 9.5 Dr
517 9.8 Bl
525 10.4 Dr
528 10.5 Dr
537 11.3 Dr
TW CYG
210129
534 11.3 Sp
X CAP
210221
498 12.7 Bl
RS AQR
210504
528 13.6 L
540 14.0 L
556[13.7 B
Z CAP
210516
466 8.9 Bf
540 12.8 B
555 13.0 Pt
R EQU
210812
466 10.6 Bf
560 12.9 B
T CEP
210868
498 6.5 Wb
511 6.4 Ch
523 5.9 Ah
524 6.2 Ch
525 5.8 Ah
532 5.8 Ah
532 6.1 Sw
534 6.2 Ch
534 5.7 Jo
540 5.8 Ah
541 6.0 Jo
541 6.2 Gy
544 6.2 Wd
546 5.8 Ah
547 5.7 Ah
550 5.8 Ah
550 5.9 Sb
555 6.1 Pt
555 6.4 Sw
558 6.3 Sb
560 6.4 Wd
562 6.2 Gy
562 6.6 Jo
562 6.7 Wb
564 6.4 Wd

J.D.Est.Obs.

RR AQR
210903
551 11.7 Gi
555 11.5 Pt
556 11.8 B
566 13.2 Gi
X PEG
211614
555 9.7 Pt
560 9 6 B
T CAP
211615
498 9.3 Bl
508 9.2 Bl
511 9.8 Ch
517 9.1 Bl
531 9.7 B
557 11.4 B
S MIC
212030
498 12.8 En
498 12.5 Bl
503 13.0 En
525 13.5 Dr
Y CAP
212814
498[12.9 Bl
511[10.5 Ch
531[13.1 B
557[13.7 B
564[11.0 Sp
W CYG
213244
526 5.8 L
528 5.9 L
534 5.9 L
540 5 8 L
545 5.8 L
S CEP
213678
555 9.5 Pt
562 9.8 Jo
RU CYG
213753
549 8.3 Bw
555 8.5 Bw
555 7.8 Pt
562 8.8 Bw
566 8.7 Bw
RV CYG
213937
528 6.9 L
531 7.0 L
540 7.0 L
555 6.3 Pt
569 7.0 Hu
RR PEG
214024
552 11.5 Lg
555 12.4 Pt

J.D.Est.Obs.

R GRU
214247
495 12.9 Ht
498[12.4 En
498 14.0 Bl
500[12.9 Ht
502[12.4 En
507[12.9 Ht
525 13.8 Dr
528 14.0 Dr
537[13 8 Dr
V PEG
215605
534 11.8 Sp
553 12.3 Lg
555 12.3 Pt
U AQR
215717
553 11.3 Lg
555 11.1 Pt
556 11.3 B
RT PEG
215934
555 10.4 Pt
RY PEG
220133a
564[12.2 Gi
RZ PEG
220133b
555 9.0 Pt
564 9.7 Gi
T PEG
220412
528[13.7 L
531 14.4 L
540 14.0 L
560[13.2 Gi
Y PEG
220613
466 11.3 Bf
RS PEG
220714
466 12.3 Bf
X AQR
221321
466 7.9 Bf
T GRU
221938
498 11.3 En
502 11.0 En
S GRU
221948
495 12.8 Ht
498[12.4 En
500 12.8 Ht
502[12.8 En
507[12.8 Ht
525 13.2 Dr

J.D.Est.Obs.

S LAC
222439
527 12.4 L
538 11.3 L
546 11.2 L
555 10.8 Pt
564 10.3 Cl
R IND
222867
498 13.0 Bl
508 12.5 Bl
517 11.5 Bl
525 10.9 Dr
528 10.7 Dr
528 10.8 Dw
537 10.3 Dr
T TUC
223462
495 12.3 Ht
498 12.3 En
500 12.3 Ht
502 12.6 En
507 12.8 Ht
525 13.1 Dr
528 13.4 Dr
528 13.5 Dw
R LAC
223841
527[14.5 L
529[14.5 L
538[14.0 L
RW PEG
225914
466 10.3 Bf
556 13.6 Pt
R PEG
230110
537 11.4 Sf
539 11.2 Ch
551 11.8 Sf
552 11.5 Lg
560 12.1 Sf
V CAS
230759
528 10.5 Sw
540 9 3 B
556 8.8 Pt
W PEG
231425
551 9.8 Gi
564 9.8 Gi
S PEG
231508
539[11.0 Ch
556 11.8 Pt
V PHE
232746
495[13.2 Ht
498[12.7 En
500[13.2 Ht

Variable Star Observations Received During November, 1928.

V Phe
232746
502[12.7 En
507[13.2 Ht
525 14.0 Dr
528[13.9 Dw
Z And
232848
539 9.8 Ch
555 10.1 Bw
556 10.1 Pt
561 10.2 Bw
ST And
233335
538 10.2 Ch
552 10.4 Lg
556 10.0 Pt
569 10.0 Hu

R Aqr
233815
495 8.9 Ht
498 8.9 En
498 8.8 Bl
500 8.9 Ht
507 8.8 Ht
508 9.0 Bl
515 8.8 Ht
517 8.7 Bl
525 8.8 En
528 9.0 L
540 8.9 L
547 8.7 L
554 8.8 Lg
556 8.6 Pt
557 8.9 Sc

R Aqr
233815
557 8.9 Sp
562 9.0 Sp
Z Cas
233956
540 11.5 B
560 12.3 Gi
RR Cas
235053
512 10.2 Bn
521 10.2 Bn
522 10.4 Ch
531 10.2 Bn
537 10.3 Bn
540 10.5 B

R Phe
235150
525 9.8 Dr
528 9.6 Dw
531 10.1 Dr
537 10.5 Dr
V Cet
235209
498 9.5 Bl
508 10.0 Bl
517 9.8 Bl
527 11.4 L
540 11.9 L
547 12.7 L
554[10.3 Lg

R Tuc
235265
498[12.9 En
502[12.6 En
R Cas
235350
521 7.2 Ah
523 7.3 Ah
525 7.2 Ah
532 7.0 Ah
540 6.8 Ah
541 7.4 Gy
547 6.7 Ah
549 6.7 Ah
550 6.6 Ah
560 7.0 Wd
562 6.7 Gy
568 7.2 Wd

Z Peg
235525
556 12.1 Pt
W Peg
235715
554 8.4 Lg
Y Cas
235855
540 11.3 B
564 10.8 Sp
SV And
235939
555 11.8 Bw
556 11.5 Pt
562 11.8 Bw

Rapidly Varying Irregular Variables.

005840 RX Andromedae—

J.D.	Est.Obs	J.D.	Est.Obs.
5532.7[	11.5 Pt	5556.7[	12.4 Pt
5540.8	12.8 Pt	5557.7[	12.4 Pt
5551.5	12.4 Pt	5558.7[	12.0 Pt
5555.7[	12.4 Pt	5561.7	11.5 Pt

060547 SS Aurigae—

5499.8[	12.4 Pt	5545.3[	12.4 L
5511.5	14.2 Bf	5546.6[	13.9 L
5521.6[	14.5 L	5547.3[	12.4 L
5522.6[	14.5 L	5548.7[	13.0 L
5526.6[	13.9 L	5550.6[	12.0 L
5527.6[	14.5 L	5551.3[	12.4 L
5528.7	15.0 L	5554.9[	14.1 Lg
5529.6[	14.5 L	5555.7[	12.6 Pt
5531.6[	14.5 L	5556.7[	12.4 Pt
5532.6[	14.5 L	5557.7[	11.4 Sp
5534.6[	14.5 L	5558.6[	13.0 Cl
5535.6[	14.5 L	5561.1[	13.3 Sp
5539.6[	14.5 L	5562.7	11.1 Pt
5540.4[	13.9 L	5564.6	10.8 Sp
5541.7[	14.5 L	5564.6	10.9 Cl
5543.6[	14.5 L	5564.7	10.8 Gi
5544.6[	13.9 L		

074922 U Geminorum—

5511.5	9.0 Bf	5535.6	13.9 L
5521.6	13.3 L	5538.6	13.6 L
5522.6	13.5 L	5539.7	13.6 L
5527.6	13.5 L	5540.6	13.7 L
5528.6	13.6 L	5541.6	13.6 L
5529.6	13.6 L	5543.7	13.8 L
5531.6	13.6 L	5544.6	13.6 L
5532.6	13.6 L	5545.6	13.7 L
5533.6	13.4 L	5546.7	13.7 L
5534.6	13.7 L	5547.6	13.7 L

081473 Z Camelopardalis—

5521.3	12.9 L	5522.6	12.8 L
5521.7	12.3 L	5523.6	12.5 L

081473 Z Camelopardalis—

5525.3	12.7 L	5539.6	12.1 L
5526.6	12.9 L	5540.3	12.4 L
5527.6	12.9 L	5540.7	12.3 L
5528.4	12.9 L	5541.6	12.4 L
5529.6	13.1 L	5542.3	12.8 L
5531.3	12.5 L	5543.2	12.7 L
5531.6	12.9 L	5543.6	12.8 L
5532.4	12.6 L	5544.7	12.6 L
5532.6	12.3 L	5545.7	12.5 L
5533.3	11.0 L	5546.2	12.7 L
5533.6	10.9 L	5546.7	12.3 L
5534.2	10.5 L	5547.3	12.5 L
5534.6	10.8 L	5548.7	12.5 L
5535.2	10.6 L	5550.2	12.9 L
5535.7	11.0 L	5551.2	11.1 L
5538.6	12.2 L	5551.6	11.0 L

094512 X Leonis—

5521.6[	12.3 L	5540.7[	13.8 L
5522.7[	13.0 L	5541.6[	13.8 L
5527.7[	12.3 L	5543.7[	13.8 L
5528.7[	14.0 L	5544.7[	13.8 L
5529.6[	14.0 L	5545.6[	13.8 L
5531.7[	14.0 L	5546.7[	14.0 L
5532.7[	13.8 L	5547.7[	13.8 L
5534.6	12.5 L	5548.7[	12.3 L
5535.6	13.3 L	5550.6	13.0 L
5538.7[	13.5 L	5551.7	12.3 L
5539.7[	14.0 L		

202946 SX Cygni—

5532.7	9.6 Pt	5555.7	8.8 Pt
5540.8	8.8 Pt	5556.7	8.9 Pt
5544.7	9.5 Pt	5557.7	9.3 Pt
5545.7	9.6 Pt	5558.7	9.3 Pt
5549.7	9.3 Pt	5561.7	9.5 Pt
5551.5	9.2 Pt	5562.6	9.4 Pt

RAPIDLY VARYING IRREGULAR VARIABLES.

Star	J.D.	Est.Obs	J.D.	Est.Obs.	Star	J.D.	Est.Obs.	J.D.	Est.Obs.
213843 SS CYGNI—					213843 SS CYGNI—				
	5511.1	9.6 Ch	5533.1	11.6 Ch		5545.3	11.7 L	5556.1	11.8 Sf
	5521.3	11.7 L	5533.3	11.4 L		5545.4	11.9 Lj	5556.6	11.6 B
	5521.3	11.7 Lj	5533.4	11.6 Lj		5545.7	11.7 Pt	5556.7	11.7 Pt
	5522.3	11.6 Lj	5533.9	11.6 Lg		5546.2	11.5 L	5557.6	11.8 Sp
	5522.3	11.4 L	5534.3	11.9 Lj		5546.3	11.8 Lj	5557.7	11.7 Pt
	5523.3	11.8 Ah	5534.3	11.6 L		5547.3	11.8 Lj	5558.6	11.7 Cl
	5524.2	11.6 Ch	5535.3	11.4 L		5547.3	12.0 L	5558.7	11.8 Lg
	5524.3	11.7 Lj	5535.3	11.8 Lj		5549.4	11.9 Lj	5558.7	11.7 Pt
	5525.3	11.8 Ah	5536.2	11.7 Ch		5549.7	11.7 Pt	5558.9	11.8 Sf
	5526.6	11.4 L	5538.6	12.0 L		5550.2	11.6 L	5559.6	11.8 B
	5527.3	11.6 Lj	5539.6	11.7 L		5551.2	11.6 L	5560.6	11.7 B
	5527.6	11.7 L	5540.3	11.8 L		5551.5	11.7 Pt	5561.1	11.8 Sf
	5528.3	11.3 Lj	5540.3	11.8 Lj		5551.9	11.8 Sf	5561.7	11.7 Pt
	5528.4	11.6 L	5540.8	11.7 Pt		5552.8	11.8 Lg	5562.6	11.7 Pt
	5529.6	11.6 L	5542.2	11.5 L		5553.8	11.8 Lg	5562.6	11.8 Sp
	5531.3	11.5 L	5543.2	11.4 L		5554.9	11.8 Lg	5564.6	11.8 Sp
	5532.3	11.8 Ah	5543.3	11.7 Lj		5555.7	11.7 Pt	5564.6	11.9 Cl
	5532.4	11.5 L	5544.3	11.9 Lj		5555.8	11.8 Lg	5569.6	11.5 Hu
	5532.7	11.7 Pt	5544.7	11.7 Pt					

MONTHLY SUMMARY FOR NOVEMBER, 1928.

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Ahnert	Ah	21	137	Hunter	Hu	17	19
Baldwin	Bl	94	216	Jones	Jo	17	33
Bappu	Bf	23	30	Kurtz	Kz	6	6
Beyer	Br	12	128	Lacchini	L	68	399
Bigelow	Bw	6	11	Leiner	Lj	11	99
Bouton	B	23	91	Logan	Lg	36	54
Brown	Bn	3	8	Peltier	Pt	173	258
Chandra	Ch	100	165	Schoenfeld	Sc	28	48
Clement	Cl	6	8	Smith, F. W.	Sf	15	42
Dartayet	Dr	61	148	Soberanes	Sb	7	21
Dawson	Dw	20	20	Spears	Sp	33	53
Ebert	Eb	8	8	Swanson	Sw	10	18
Ensor	En	45	96	Waterfield	Wf	1	6
Gaebler	Gb	1	1	Webb	Wd	12	30
Gregory	Gy	10	12	White	Wb	11	24
Guiler	Gi	11	14	Whitney	Wy	12	18
Haas	Hs	3	5				
Houghton	Ht	27	97	Totals		34	397	2323

We welcome to the ranks of active observers Misses Bigelow and Guiler at Smith College, Northampton, Massachusetts; Wm. Braid White of Chicago, Illinois, and Dr. B. H. Dawson of La Plata, Argentina. Mr. Whitney reports for the first time with observations made with the A.A.A.S. 5-inch glass, recently lent to him by this Association.

Two stars require rather special attention. The first, SU Tauri, 054319, has been long on our list and has had a somewhat hectic career. Mr. F. W. Smith reported it below tenth magnitude early in November, and later observations at Harvard indicated that it had dropped to nearly the thirteenth magnitude. At this writing it is doubtless way out of sight of all except the most powerful instruments. In December, 1925, a similar drop occurred, and also in August, 1924. Previously to 1924, the star had remained at constant brightness for seven years.

This is one of the few stars of the R Cor. Bor. type, of which others are gradually being found.

The second star is one recently observed by Sig. Lacchini, Z Camelopardalis, 081473, and it now looks as if it might be somewhat allied to stars of the SS Cygni type. It has proven so interesting that a chart has been recently prepared so that other observers may be able to follow it assiduously. It is somewhat faint, especially at minimum, and accordingly is suitable only for the larger size instruments.

LEON CAMPBELL, Recording Secretary.

December 3, 1928.

METEOR NOTES.

By CHARLES P. OLIVIER.

As it is necessary to mail this month's Meteor Notes earlier than usual, some of the reports on the Leonids will not appear until a later date as they have not yet arrived at headquarters. Thanks, however, to the campaign inaugurated by Science Service, and carried on by numerous newspapers, and to various persons who are not members of the A.M.S., we have enough reliable reports to indicate very well the character of this return of the Leonids. Though the Texas observations have not arrived, we know that they were made, and the writer observed here in Pennsylvania, but he regrets to say that if any other members of the A.M.S. in America did anything whatever on the Leonids nothing has been heard of it here. With our large and growing membership this is a curious situation.

By an unfortunate misunderstanding the newspapers made it appear that observations were wanted only on the night of November 14, or according to civil time the early morning of November 15. Hence several persons made no effort to observe regularly the next two nights, when such records would have been equally valuable. But we have data enough to say that this return was a good one. The Leonids furnished many bright meteors—some really splendid fireballs. So far as this can safely be used as an indication, it increases the chances for better showers the next few years. Perhaps we may even see a "great shower" in 1932 or 1923; certainly this return raises our hopes considerably. Details of the work done by various observers follows in a condensed form. The only radiant so far reported was by Olivier, the coördinates being $\alpha = 150°$, $\delta = +24°$, 17 meteors. The radiant area was about 3° in radius. It might be well to say that all the dates given are in (old) astronomical time, as is the general practice in all publications of the A.M.S.

LEONIDS FOR NOVEMBER, 1928.

MR. AND MRS. WM. B. BURCHARD AND SON, Biolo, Fresno County, Calif. Very clear, F = 1.0. Outdoors, observing in all directions. "Many meteors seen also on Nov. 15."

1928 Nov. 14	12:00 to 12:30	2	One fine fireball.
	12:30 to 13:00	5	
	13:00 to 13:30	8	
	13:30 to 14:00	14	
	14:00 to 14:30	18	
		47	

Mrs. W. H. Edwards, Fairhope, Alabama.

1928 Nov. 14	14:30 to 15:00	14	Two fireballs.
	15:00 to 15:30	13	
	15:30 to 16:00	16	
		43	

Prof. H. H. Ninenger and one assistant, McPherson College, McPherson, Kansas.

1928 Nov. 13	9 to 15 hours, at intervals, nothing of interest.		
Nov. 14	16:45 to 17:20	36	25 were Leonids.

C. P. Olivier, Flower Observatory, Upper Darby, Pa. Some clouds, F = 0.6.

1928 Nov. 15	13:01 to 16:46	44	Actually observing 210 min.; 34 were Leonids, 3 brilliant Leonids.

Dr. Joel Stebbins and 5 students, Washburn Observatory, Madison, Wis. Clear, F = 1.0. All of sky except to west well observed.

		L	S	Total	
1928 Nov. 14	14:00 to 14:30	13	5	18	One Leonid fireball,
	14:30 to 15:00	18	7	25	equal to crescent moon,
	15:00 to 15:30	14	3	17	trail lasting 12 min. to
	15:30 to 16:00	17	7	24	naked eye. Many Leonids
	16:00 to 16:30	23	4	27	1 magn. or brighter.
		85	26	111	

Prof. Robert Stratton and C. L. Sheets, A. and M. College, Stillwater, Okla. Haze low, F = 0.7.

1928 Nov. 14	12:15 to 12:45	3	One fireball, 6 bright. Leo not
	12:45 to 13:15	12	out of haze until 13:30.
	13:15 to 13:45	10	
	13:45 to 14:15	15	
		40	

Frank Glasgow, Buffalo, N. Y.

15:00 to 15:30	3	One fireball.

B. Grninski, Buffalo, N. Y.

17:13 to 17:40	3	

Miss Mary H. Sherhan, W. Concord, Mass.

9:00 to 13:30	5	(probably intermittent watches)

Miss Helen Rhoads, Glendale, Calif.

14:00 to 16:00	3	One fireball.

A number of brilliant fireballs have been reported in the past two months. More observations on those of October 15, 16, 20, and November 14 and 15 would be of particular use, as they would probably allow us to solve for their heights and orbits. Our members are urged to impress upon their friends as well as themselves the importance of sending in observations of brilliant objects. As one sees few in a lifetime, the labor of reporting is not great.

Franklin W. Smith, observing with the 5-inch refractor of the Students' Observatory at Swarthmore College, Pennsylvania, on November 11 from 7:30 to 10:00 E.S.T., saw 11 meteors in the 1° field of the telescope. The first appeared at 7:34, the last at 9:16. They varied from magnitude 6 to 8 inclusive. The telescope was pointing at $\alpha = 8^{\circ}5$, $\delta = +39^{\circ}8$. As he gave the approximate position angles of the paths, the writer later will attempt to determine a radiant, calculate the corresponding elements, and see if these possibly could be debris from the Bielids.

A delayed account of the Perseids comes from Prof. H. H. Ninenger of McPherson College, Kansas. He and two boys, at Palmer Lake, Colorado, elevation

7300 and with an excellent sky, counted 134 meteors on August 11 from 13:15 to 14:00. About 10:00 o'clock he had seen 20 more in a short interval. He also observed at McPherson, Kansas, on October 20, 17:10 to 17:40, seeing 16 meteors, 14 being Orionids, as is proved by an accompanying chart.

Very full reports have come from R. A. McIntosh on the Orionids, in which he derives excellent radiants, for several nights. This will form the basis of a separate paper. The Texas observers, Bunch, Logan, Monnig and Saunders, working together on the night of September 16 at a station 15 miles N.W. of Fort Worth, plotted 38 meteors. The writer has derived the following radiants from these positions:

α	δ	Meteors	
43	+25	4	Good
80	+47.5	5	Good
84	+ 6	6	Good
355	— 7.5	3	Fair

The principal interest is in that at $\alpha = 84°$, $\delta = +6°$, because it is so near the two determined by McIntosh on September 18.67 at $\alpha = 92°.9$, $\delta = -1°.0$ and on September 19.67 at $\alpha = 94°.5$, $\delta = 0°.0$. As the Texas observations antedate the New Zealand ones and have a smaller right ascension for the radiant, it looks like a strong case for a connection. It is true that the declination is 6° different, but perhaps much of this can be due to effects of zenith attraction, which would make the New Zealand ones too far south, the American ones too far north. The writer will attempt to apply these corrections and work out orbits from these interesting radiants.

We welcome as new members the following:

Robert Specht, 2263 S. W. Fifth Street, Miami, Florida.
Robert Brown, 3333 Ryan Avenue, Fort Worth, Texas.

As so often stated the writer will be glad to answer the inquiries of all persons interested in joining the American Meteor Society. We are most happy to have such persons look carefully into the matter, as the need for regular observers in most states is still lamentably great.

Flower Observatory, Upper Darby, Pennsylvania, 1928 December 7.

P.S.—Just as this was about to be mailed the Texas observations arrived. While impossible to review them here, briefly they consist of 354 observations made by 7 persons. The nights covered were November 10, 17, and 19, the intervening ones being cloudy. They prove that Leonids were appearing on all these dates in considerable numbers. These excellent observations will be fully worked up later.

COMET NOTES.

By G. VAN BIESBROECK.

Comet 1928 *c* (Forbes). The third new comet of this year was found November 19 at Cape Town by Forbes. This is probably Mr. A. F. I. Forbes of Rosebank, who has been an active member of the Astronomical Society of South Africa. In Vol. 2 of the Journal of this association we find under his name a description of a tripod stand which can easily be made by any amateur. The

telegram announcing the discovery gave the following particulars:

Magnitude 6. Nov. 21 at 2^h U.T. $\alpha = 12^h\,8^m.5$, $\delta = -21°\,42'$
Daily motion, $+1^m.3$ $-50'$

The following observations have been circulated since then:

U. T.	h m s	° ′ ″	M	
Nov. 24.21465	12 17 2.6	−23 58 53	10	Algiers
24.57167	17 59.7	24 13 32	7	Lick-Berman
25.47529	20 26.95	24 49 45.8	10	Kerkes-Van Biesbroeck
25.5597	20 39.9	24 53 4	9	Lick-Berman
26.47980	23 9.36	25 58 59.6	11	Yerkes-Van Biesbroeck
Dec. 5.48090	46 48.56	30 30 41.8	12	Yerkes-Van Biesbroeck
6.48978	12 49 22.64	−30 59 55.2	12	Yerkes-Van Biesbroeck

On November 24, the first clear morning that gave a chance to look for the object at the Yerkes Observatory, several observers hunted for it shortly before sunrise, hoping to see a comet visible to the naked eye, but no one found it. A photographic search made on November 25 with the Bruce 10-inch lens brought out the object as a faint diffuse spot, the total brightness of which was hardly more than that of a 10th magnitude star. The very hazy appearance of the object accounts for the discrepancy in the estimation of the brightness. Further photographic records obtained with the 24-inch reflector have shown a very rapid decrease in brightness, which cannot all be explained by the lower altitude above the horizon. The following additional positions were obtained here:

U. T.	h m s	° ′ ″
Dec. 8.47988	12 54 21.15	−31 55 9.4
9.48678	56 50.03	−32 22 2.7
10.48032	12 59 15.77	−32 47 48.6

On the last date the object was very faint and diffuse and therefore hard to measure. A last plate on December 11 no longer gave a measurable image.

From the first observations three sets of elements have been computed as follows (1928.0):

	Berkeley	C. H. Smiley	A. C. D. Crommelin
T (U.T.) =	Oct. 28.93	Nov. 17.0287	Nov. 7.0404
ω =	188° 47′	208° 48′.8	198° 32′.1
Ω =	260 36	239 50.6	248 59.1
i =	30 46	25 32.2	28 39.4
q =	0.775	0.7543	0.74724

On account of the rapid decrease in brightness and southerly declination we do not give the ephemeris which indicates increasing distances from both earth and sun. Crommelin has computed the position before discovery and shown that northern observers have not been watching the sky assiduously because earlier in November and in October the comet must have been brighter and very well situated in the morning sky. Luckily the new object did not escape the watch of the vigilant group of comet hunters in South Africa. In spite of the severe loss in their ranks that recently occurred through the untimely death of William Reid, they keep up the tradition established in the last decade.

While the comet will thus be very short-lived as far as visibility goes, it gains in interest from the fact that it seems to be a periodic one coming back to us after 55 years. The Berkeley computers call attention to some similarity of their orbit with that of comet 1911 V (Brooks). The agreement is, however, hardly close enough for identity, the difference being especially large in the perihelion distance which was found to be 0.49 astronomical units for Brooks' comet, not to mention

its period of over 2000 years. Both Crommelin and Smiley make a much better case with comet 1873 VII. Found on November 10 by Coggia at Marseille and independently on November 11 by Winnecke at Strasburg, this comet was described as a pale disk some 3′ in diameter, surrounded by a faint nebulosity, rapidly decreasing in brightness during its swift southerly motion. It was followed for five days only. From this short arc Weiss deduced the elements:

$$\left.\begin{aligned} T &= 1873\ \text{Dec.}\ 1.59\ \text{G.M.T.} \\ \omega &= 195^\circ\ 41'.2 \\ \Omega &= 250\ \ 43.5 \\ i &= \ \ 29\ \ 18.4 \\ q &= 0.74322 \end{aligned}\right\}\ (1928)$$

and several computers at that time noticed a striking similarity of these elements with those of an earlier comet 1818 I, discovered by Pons at Marseille on February 23 of that year. Schulhof has made elaborate computations in order to find if more than one revolution might have elapsed during the 55 years between 1818 and 1873. A decision in the matter was made difficult by the precarious character of the positions estimated by Pons: only rough data without indication of time are given for the interval February 23 to 27, and nobody else has observed the comet. Schulhof, nevertheless, concludes in favor of the longest period of 55 years and this period seems to have brought the object back to our vicinity this fall. Even though the evidence might appear weak, the indications are that we should add this object to the list of periodic comets.

Further observations have been secured on the faint COMET 1927 *d* (STEARNS) and 1927 *j* (SCHWASSMANN-WACHMANN).

The correction of the ephemeris of the first one, given on p. 506 of Volume XXXVI, was +13° and —0′.4 from measures by the writer on December 10. Since the object stays in reach of large instruments I have computed the continuation of the ephemeris for the next semester.

EPHEMERIS OF COMET 1927 *d* (STEARNS).

1929 0^h U.T.	α h m s	δ ° ′	Log. r	Log. Δ	Mag.
Jan. 5	18 53 52	+58 13.4	0.820	0.825	15.2
13	19 6 29	58 38.1	.823	.829	
21	18 37	58 59.2	.826	.833	
29	30 46	59 29.2	.829	.837	
Feb. 6	42 40	60 3.5	.833	.841	15.4
14	19 54 19	60 41.9	.836	.845	
22	20 5 37	61 23.9	.839	.849	
Mar. 2	16 30	62 9.2	.842	.853	
10	26 57	62 57.6	.845	.857	15.5
18	36 52	63 48.7	.849	.861	
26	46 12	64 41.8	.852	.865	
Apr. 3	20 54 51	65 36.6	.855	.869	
11	21 2 48	66 32.7	.858	.872	15.7
19	9 53	67 29.7	.861	.875	
27	16 3	68 27.0	.864	.878	
May 5	21 9	69 24.0	.867	.881	
13	25 6	70 20.3	.870	.884	15.8
21	27 45	71 15.0	.873	.886	
29	28 56	72 7.5	.876	.888	
June 6	28 34	72 56.9	.879	.890	
14	21 26 33	+73 42.4	0.882	0.892	15.9

It will be seen that the comet travels slowly through the constellation of Draco

and reaches still higher declinations while the theoretical magnitude decreases very slowly.

COMET 1927 *j* was observed near the limit of visibility with the 40-inch telescope on December 11; it appeared as a round diffuse coma some 15″ in diameter but it was not brighter than 16^M. It is now again well in reach of photographic observations with the two-foot reflector.

Williams Bay, Wisconsin, December 14, 1928.

Professor H. F. Newall, director of the Solar Physics Observatory of Cambridge University, has resigned from active duties, the resignation taking effect at the close of the University term ending December 19. Professor Newall has had a large part in the development of astrophysics in Cambridge since 1890. In 1909 he became the first director of the Solar Physics Observatory which was then established at South Kensington, and was moved to Cambridge in 1913. At a dinner in London on November 9, his retirement was referred to and the hope that he might, nevertheless, for many years continue as a member of the astronomical fraternity was unanimously expressed.

BOOK REVIEW.

Introduction to Modern Physics by F. K. Richtmyer. (McGraw-Hill Book Co., New York, 1928. 596 pages, 169 illustrations. Price $5.00).

In the first three chapters of this book the author sketches the historical development of the important physical theories from earliest times to 1890 A.D. This section of the book gives a clear conception of the growth and development of various fundamental theories. For example, in the treatment of the law of gravitation the reader is presented with the facts with which Newton was familiar and which led him to the discovery of the universal law of gravitation. Modern physics dates from about 1890 and the remainder of the book deals with the developments in physics since that time. In the chapter on the electromagnetic theory of light Maxwell's equations are developed. The formulae for the magnetic field produced by a moving charge and the energy radiated by an accelerated charge are derived. A chapter is given to a discussion of the photoelectric effect. The classical laws for the problem of black body radiation are derived and their failure to explain the experimental results is shown. This leads to the derivation of Planck's law for black body radiation and to a discussion of some of the physical implications of the quantum theory. The problems of specific heats and series relations in line spectra are discussed from the view point of the quantum theory. Bohr's theory of the atom is treated at length. No discussion is included of the wave theory of the atom. X-rays and the structure of the nucleus form the subjects of the last two chapters. The book contains many fundamental mathematical derivations, many of them of fundamental importance to the student of astrophysics. In general these are accompanied by a clear explanation of their physical meaning so that the reader does not feel that the mathematics is a burden. The author's style of exposition is such that the student will find not only profit but enjoyment in the reading of this book. —R. M. M.